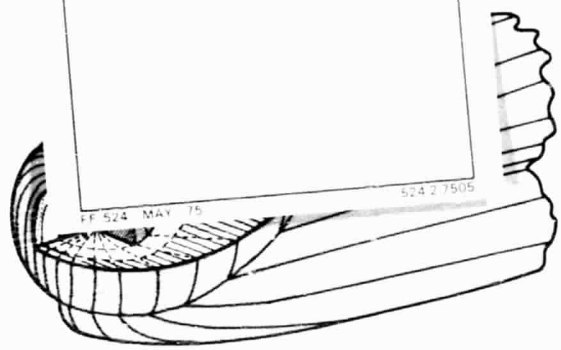
NASA-TMX 72585



WDC-A / NSSDC

World Data Center A for Rockets and Satellites
National Space Science Data Center
Code 601
Goddard Space Flight Center
Greenbelt, Maryland, U.S.A. 20771

(NASA-TM-X-72585) IMS/SATELLITE SITUATION CENTER REPORT (NASA) 42 p HC $4.00 CSCL 22C

N76-15214

Unclas
G3/13 08500

IMS/Satellite Situation Center Report

REPORT NO. 1

JUNE 1973

I. INTRODUCTION

This document is a trial report from the IMS/Satellite Situation Center (SSC) and is being produced to give the scientists participating in the IMS an opportunity to learn what kind of services are being planned. This Report will not be issued regularly until the IMS begins in 1976, but it will be produced occasionally before that time.

A questionnaire is enclosed that gives each recipient the opportunity to express certain preferences. The completed questionnaires will give the SSC some indication of the number of people who want to receive the services described in this Report during the IMS period. Since the resources for operating the SSC are limited, each person should be realistic in completing the questionnaire and should ensure that a single copy of the Report will be shared with as many interested persons as possible. We would like to receive all completed questionnaires by August 1, 1973, so that a compilation of the data can be made in time for the Kyoto meeting in September 1973.

The IMS/SSC is operated by the National Space Science Data Center (NSSDC)/WDC-A for Rockets and Satellites under the guidance of an Ad Hoc Advisory Group that reports to the SCOSTEP IMS Steering Committee. The members of the Advisory Group are:

M. Sugiura (Convenor)
Code 645.1
Goddard Space Flight Center
Greenbelt, Maryland 20771 U.S.A.

K. G. Lenhart
ESOC/ESRO
5 Robert Bosch Strasse
61 Darmstadt
Federal Republic of Germany

D. J. Williams
Space Environment Laboratory
ERL/NOAA
325 Broadway
Boulder, Colorado 80302 U.S.A.

T. Obayashi
Institute of Space and
Aeronautical Science
University of Tokyo
Komaba, Meguro-Ku
Tokyo 153, Japan

M. Lefebvre
Groupe de Recherche
de Géodésie Spatiale
92 Meudon, France

The major activities of the SSC will be:

(a) to provide data on the predicted positions of IMS satellites approximately one month in advance for the planning of GBR- (ground-based-, balloon-, and rocket-) or multiple-satellite measurements

(b) to obtain refined orbital position data from the responsible orbit determination groups, so that nonsatellite experimenters requiring these data for their work will have a central place from which to order this type of data

(c) to respond to inquiries regarding both satellite experiments and positions, and specially planned measurement projects involving GBR and multiple satellites

(d) to select planned and retrospective intervals for special studies in conjunction with the MONSEE and IMS Steering Committees

(e) to maintain a summary of planned and active satellite experiments, including status information, and to issue status summaries periodically

Note that the SSC is not a data exchange center for satellite experiment data. Although much of the satellite data taken during the IMS will eventually be deposited in NSSDC, the normal time delay of three to four years after launch dictates that data exchange during the IMS be conducted directly with the experimenters. The SSC will act as a switching center to direct IMS scientists to the appropriate satellite principal investigators to obtain their required data.

To carry out its duties, the SSC is planning to issue the following reports:

(a) SPACEWARN Bulletin - biweekly

(b) Sounding Rocket Launching (SRL) Report - monthly

(c) Status Report of Active and Planned IMS Spacecraft and Experiments - quarterly

(d) IMS/Satellite Situation Center Report - monthly

The status of active ground-based stations will be maintained by other WDCs and will be reported in the MONSEE Bulletin. Copies of SPACEWARN and SRL are currently being produced by NSSDC/WDC-A, and samples of them are enclosed as attachments to this trial report. NSSDC/WDC-A presently sends out 391 copies of SPACEWARN and 208 copies of SRL, and some of you probably already receive one or both of these reports. This trial SSC Report is being distributed through the National STP Affiliates and Contacts; consequently, we do not yet know who the individual recipients will be. An example, using the ISIS 2 satellite, of the planned format of the Status Report, (c) listed above, is enclosed as Appendix 1.

II. STRUCTURE OF THE SSC REPORT

At our present stage of planning, we have decided on a structure for the SSC Report similar to the one used here. There will be a section of special announcements that will give planned special observation periods, retrospective intervals for special studies, and planned rocket and balloon launches. Occasionally the Report will include a brief catalogue of orbital position data giving the time periods covered, the forms of the data, and the locations of the data if they are not yet available through the SSC. The predicted orbital positions of the satellites will be depicted in several ways depending upon the type of orbit. Examples of these presentations will be given in this trial Report using the presently operating satellites ESRO 4, HEOS 2, and ISIS 2 for the time period April 15 through May 30, 1973. (Day 105 through 150.)

In order to distribute this Report in a timely and inexpensive manner during the IMS, we plan to send it airmail one week after production begins. The predicted orbits will be given for a 6-week interval starting with the day we begin production of the Report. Consequently, most people should receive the Report in time to have three or four weeks of predicted positions.

Since both the IMS Steering Committee and SSC Advisory Group recommended including plots of all the IMS satellites, the Report will run approximately 200 pages if there are 20 satellites. For such a lengthy report, printing is not feasible with a turnaround time of one or two days. Consequently, we are planning to distribute it in the form of 35-mm microfilm. This trial Report includes some illustrations of the types of plots we plan to make. Selected time periods over the interval April 15 through May 30, 1973, are included as hard copy (Figures 1 through 15) in this Report. Complete coverage of this time interval is available on one reel of 35-mm microfilm, a copy of which has been sent to each National STP Affiliate or Contact. The questionnaire allows recipients of this Report to request a reel if they want to see the examples that cover the entire time interval.

III. SPECIAL ANNOUNCEMENTS

The time intervals

- February 19 through 23, 1970
- November 29 through December 3, 1970
- July 26 through August 14, 1972

have been declared retrospective intervals for special study. The WDC-A for Geophysics and Solar-Terrestrial Physics is compiling a summary data report for the July-August 1972 period that will be published this summer and will begin compiling summary data reports for the other two intervals.

IV. ORBITAL PARAMETER SUMMARY

The predicted orbital parameters for ISIS 2 (1971-024A), HEOS 2 (1972-005A), and ESRO 4 (1972-092A) used in the calculations are given in Table 1. We list in the table other parameters that will be useful for geostationary and heliocentric satellites.

V. ENTRY AND EXIT TIMES FOR HIGHLY ELLIPTICAL SATELLITES

For highly elliptical satellites, it may be useful to know which region of space the satellite is traversing as a function of time. The space has been divided into the following seven regions:

(a) Interplanetary medium

(b) Dayside magnetosheath

(c) Nightside magnetosheath

(d) Dayside magnetosphere

(e) Nightside magnetosphere ($-10\ R_E < X_{GSE} < 0$)

(f) High-latitude magnetotail
($X_{GSM} < -10\ R_E$; $|Z_{GSM} - Z_{neutral\ sheet}| > 6\ R_E$)

(g) Low-latitude magnetotail
($X_{GSM} < -10\ R_E$; $|Z_{GSM} - Z_{neutral\ sheet}| < 6\ R_E$)

Table 2 contains the above information for HEOS 2. It is not practical to do the equivalent for low-altitude satellites since their periods are so short there would be too many tables.

VI. PLOTS FOR HIGHLY ELLIPTICAL EARTH SATELLITES

In order to show the position of a satellite with respect to the neutral sheet, we have chosen a projection of the orbit on the Geocentric Solar Magnetospheric Y-Z plane. The idealized position of the neutral sheet is obtained by considering that it is hinged to the geomagnetic equator at 10 R_E and assumes the antisolar direction at this point. Figure 1 shows this for a complete revolution of HEOS 2 beginning on April 15, 1973, 0000UT. We show ancther revolutior. covering the period May 26 to May 30, 1973, in Figure 2. Unfortunately, HEOS 2 did not traverse the neutral sheet during the time interval under study. Solid curves are used if $X_{GSM} > -20\ R_E$; otherwise, dashed curves are used. The numbers along trajectories refer to the tables of times and radial distances at the bottom of the graphs. If the orientation of the orbit is such that a satcllite will not traverse the neutral sheet (as is the case here), these plots normally will be deleted from the Report.

To show the position of the satellite with respect to the average bow shock and magnetopause positions, we have used the scheme of rotating the radius vector into the solar ecliptic plane (X-Y) using the following relation.

If $X_{GSE} > 0$, maintain the GSE longitude constant.

If $X_{GSE} < 0$, maintain X_{GSE} constant.

The average position of the bow shock and magnetopause are shown as dashed lines and have been taken from Fairfield's determination. Examples of this type of plot are given in Figures 3 and 4.

To give some indication of when the satellite may be near the cusp or cleft region, the positions are plotted giving magnetic latitude as a function of magnetic loca. time. An example of this type of plot is given in Figure 5 for HEOS 2. Radial distance for each annotated point is given in the table at the bottom of the figure.

VII. LOW-ALTITUDE SATELLITES - PLOTS AND FLUX TUBE INTERSECTION

Since most low-altitude satellites execute 12 to 16 revolutions per day, it is impractical to present their predicted orbits in the same manner as the highly elliptical ones. Initial plans were to show the approximate B-L (magnetic field-McIlwain parameter) coverage by presenting approximately 12 revolutions from every fourth day for each such satellite. Examples of these for ESRO 4 and ISIS 2 are given in Figures 6 through 9 for the days April 15, 1973, and May 29, 1973. Since the coverage does not change much over this time period, the intermediate plots may not be necessary.

In addition, we plan to give the polar projection onto the surface of the earth for each low-altitude satellite using magnetic latitude and magnetic local time as the coordinate grid. This will be done for about three revolutions every fourth day in order to show whether the passes are dawn-dusk, noon-midnight, etc., for the polar-orbiting satellite. This mode of presentation is illustrated in Figures 10 through 13 using ESRO 4 and ISIS 2. The solid lines correspond to Northern Hemisphere portions of the orbit, and the dashed lines correspond to Southern Hemisphere portions.

For a limited number of ground-based stations, the SSC plans to offer predictions of the approximate time of entry into and exit from the flux tube passing through the station. This portion of the monthly Report will be sent only to the stations involved and will include only those satellites in which they are interested. An example of the data that will be supplied is given in Tables 3A and 3B using the station SANAE and the satellites ESRO 4 and ISIS 2, respectively. The flux tube for this station has been defined by field lines that start from the earth's surface at a geomagnetic latitude of ±5° and geomagnetic longitude of ±5° from the station. One can see that polar-orbiting satellites intersect a given flux tube from two to four times a day. However, the intersection of satellites in highly elliptical orbits is very rare. In fact, for this trial period of April 15 through May 31, 1973, HEOS 2 intersected this flux tube three times. Since this service requires a considerable amount of computer time, it will have to be limited to special periods and to special stations. IMS/SSC will have a better idea of the need for this service after we receive the completed questionnaires.

VIII. GEOSTATIONARY AND HELIOCENTRIC SATELLITES

For geostationary satellites, the position of the satellite can be adequately described by the entries in Table 1 (IMS/SSC Orbital Parameter Summary) and a statement about the longitudinal drift. For

heliocentric satellites, the orbit can be predicted years in advance. For flyby missions, an update would be required after encounter. Besides listing the orbital elements, plots giving heliocentric radial distance, earth-sun-satellite angle, and corotation delay time can be produced. Examples of some earlier plots of these types using Pioneer 6, 7, 8, and 9 are given in Figures 14 and 15.

QUESTIONNAIRE FOR PARTICIPANTS IN THE IMS

Name	Position
Affiliation	
Address	

Please complete and return this questionnaire by August 1, 1973, to

WDC-A/National Space Science Data Center
Code 601
Goddard Space Flight Center
Greenbelt, Maryland 20771 U.S.A.

1. Which of the following reports issued by the IMS/Satellite Situation Center do you wish to receive?

☐ SPACEWARN Bulletin	Biweekly, available now
☐ Sounding Rocket Launching (SRL) Report	Monthly, available now
☐ IMS/Satellite Situation Center Report	Monthly, during IMS
☐ Status Report of Active and Planned Spacecraft and Experiments	Quarterly, during IMS

2. During the IMS do you require tables of the intersection of satellites with the flux tube passing through a ground station?

☐ Yes ☐ No

If yes, for which planned satellites would you want these monthly predictions?

1. ______________ 5. ______________

2. ______________ 6. ______________

3. ______________ 7. ______________

4. ______________ 8. ______________

What is the name of the station? ______________

What are the coordinates of the station?

Latitude __________ Longitude ________ Altitude _______

☐ Geodetic ☐ Geographic

3. Are there other projections of the predicted satellite positions you would prefer to have in place of the ones that are illustrated in this trial Report? If yes, please list.

4. Would you prefer to have a printed Report without the satellite plots?

☐ Yes ☐ No

5. In your IMS work, will you require predicted satellite plots?

☐ Yes ☐ No

Which form can you use?

☐ 35-mm microfilm only ☐ 16-mm microfilm only

☐ Either 16- or 35-mm microfilm ☐ Can't use either

6. Satellite experimenters will receive refined orbital position data from the computation centers responsible for orbit determination of specific satellites. Will you have any need to obtain such position data from the Satellite Situation Center?

☐ Yes ☐ No

What form(s) will you be requesting?

☐ Magnetic tape ☐ Computer printout on microfilm ☐ Computer printout

7. Do you wish to receive a copy of the plots for this trial Report on 35-mm microfilm?

☐ Yes ☐ No

TABLE 1. IMS/SSC ORBITAL PARAMETER SUMMARY

SATELLITE NAME	ISIS 2	ESRO 4	HEOS 2
INTERNATIONAL ID.	71-024A	72-092A	72-005A
EPOCH (YY-MM-DD-HH-MM)	73-04-06-00-00	73-04-07-00-00	73-04-08-17-22
PERIOD (min)	113.54878	97.12707	7483.41086
ECCENTRICITY	.004517	.055384	.908334
INCLINATION (deg)	88.181	91.098	88.261
R.A. OF ASCENDING NODE (deg)	176.052	143.503	92.473
ARGUMENT OF PERIGEE (deg)	116.193	56.835	294.252
MEAN ANOMALY (deg)	14.725	224.188	158.785
SEMI-MAJOR AXIS (km)	7,767.537	6,999.310	126,734.469
LONGITUDE OF SATELLITE (deg)	This will be given for geostationary satellites.		
PERIGEE HEIGHT (km)	1354.46	233.50	5239.10
APOGEE HEIGHT (km)	1424.46	1008.79	235,473.50
LOCAL TIME OF APOGEE (hr min)	22 30.0	8 24.4	4 35.9
LATITUDE OF PERIGEE (deg)	63.748	56.819	65.690
SUN-SATELLITE DISTANCE (AU)	This will be given for heliocentric satellites.		
EARTH-SUN-SATELLITE ANGLE (degs)	This will be given for heliocentric satellites.		
COROTATION DELAY TIME (days)	This will be given for heliocentric satellites.		

TABLE 2*. ENTRY AND EXIT TIMES FOR HEOS 2 (72-005A)

INTERPLANETARY MEDIUM	DAYSIDE MAGNETOSHEATH	NIGHTSIDE MAGNETOSHEATH	DAYSIDE MAGNETOSPHERE	NIGHTSIDE MAGNETOSPHERE	HIGH-LATITUDE MAGNETOTAIL	LOW-LATITUDE MAGNETOTAIL
105.0.00-105.21.98	107.1.52-107.5.93	105.21.98-106.9.77	106.19.8-107.1.52	106.9.77-106.19.8	Not entered by HEOS 2 for the period: 105.0.00 to 150.21.33	Not entered by HEOS 2 for the period: 105.0.00 to 150.21.33
107.5.93-111.2.57	112.4.92-112.8.98	111.2.57-111.14.35	112.0.52-112.4.92	111.14.35-112.0.52		
112.8.98-116.7.12	117.9.22-117.13.22	116.7.12-116.18.88	117.5.05-117.9.22	116.18.88-117.5.05		
117.13.22-121.11.70	122.13.93-122.18.00	121.11.70-121.23.43	122.9.65-122.13.93	121.23.43-122.9.65		
122.18.00-126.16.27	127.18.58-127.22.68	126.16.27-127.3.93	127.14.70-127.18.58	127.3.93-127.14.20		
127.22.68-131.20.88	132.23.25-133.3.40	131.20.88-132.8.53	132.18.80-132.23.25	132.8.53-132.18.80		
133.3.40-137.1.48	138.3.83-138.8.00	137.1.48-137.13.10	137.23.35-138.3.83	137.13.10-137.23.35		
138.8.00-142.6.17	143.8.45-143.12.60	142.6.17-142.17.72	143.3.92-143.8.45	142.17.72-143.3.92		
143.12.60-147.10.82	148.12.97-148.17.08	147.10.82-147.22.32	148.8.45-148.12.97	147.22.32-148.8.45		
148.17.08-150.21.33						

*Time is given as day of year for 1973 and decimal hours of day.

TABLE 3A. FLUX TUBE INTERSECTIONS

STATION - SANAE

SATELLITE	ENTRY DATE YYMMDD	ENTRY TIME HHMM	ENTRY LAT DEG	ENTRY LONG DEG	ENTRY ALT KM.	EXIT DATE YYMMDD	EXIT TIME HHMM	EXIT LAT DEG	EXIT LONG DEG	EXIT ALT KM.
ESRO-4	730415	846	-63.40	-12.40	935.08	730415	848	-66.80	-13.02	919.56
ESRO-4	730415	2020	-70.35	-1.04	646.62	730415	2022	-66.67	-1.82	621.53
ESRO-4	730415	2227	48.45	-37.18	262.24	730415	2229	52.56	-37.63	272.64
ESRO-4	730416	730	-71.08	4.78	880.49	730416	731	-71.08	4.78	880.49
ESRO-4	730416	2039	-70.11	-6.69	620.26	730416	2042	-62.67	-8.10	570.04
ESRO-4	730416	2246	49.12	-42.82	273.75	730416	2249	57.28	-43.76	299.45
ESRO-4	730417	748	-67.63	-0.04	879.47	730417	750	-71.07	-0.82	860.38
ESRO-4	730417	1028	49.27	-36.19	742.40	730417	1030	45.71	-36.59	765.98
ESRO-4	730417	2058	-69.84	-12.34	593.86	730417	2101	-62.34	-13.74	543.89
ESRO-4	730418	806	-64.17	-5.00	878.45	730418	809	-71.08	-6.43	839.22
ESRO-4	730418	1045	56.32	-40.92	719.05	730418	1049	45.64	-42.20	789.55
ESRO-4	730418	1939	-72.31	7.06	587.65	730418	1940	-72.31	7.06	587.65
ESRO-4	730419	825	-64.16	-10.60	858.23	730419	828	-71.11	-12.05	817.10
ESRO-4	730419	1958	-72.01	1.39	561.36	730419	2000	-69.24	0.51	536.55
ESRO-4	730419	2205	47.99	-35.04	306.06	730419	2206	47.99	-35.04	306.06
ESRO-4	730420	709	-72.10	6.46	789.71	730420	710	-72.10	6.46	789.71
ESRO-4	730420	2017	-71.68	-4.28	535.30	730420	2020	-64.05	-5.85	486.81
ESRO-4	730420	2224	48.59	-40.67	322.92	730420	2227	56.62	-41.60	357.95
ESRO-4	730421	727	-68.64	1.69	788.51	730421	729	-72.18	0.83	765.78
ESRO-4	730421	2036	-71.31	-9.96	509.61	730421	2039	-63.63	-11.50	462.16
ESRO-4	730421	2243	49.17	-46.31	341.23	730421	2244	49.17	-46.31	341.23
ESRO-4	730422	745	-65.19	-3.23	787.29	730422	748	-72.28	-4.80	741.17
ESRO-4	730422	1024	55.07	-39.12	818.41	730422	1027	48.12	-39.97	859.37
ESRO-4	730423	803	-61.74	-8.26	786.06	730423	807	-72.42	-10.43	715.98
ESRO-4	730423	1043	55.06	-44.73	839.92	730423	1046	48.14	-45.58	878.87
ESRO-4	730423	1937	-69.50	2.82	455.32	730423	1938	-69.50	2.82	455.32
ESRO-4	730424	822	-61.82	-13.87	762.02	730424	823	-61.82	-13.87	762.02
ESRO-4	730424	1955	-72.93	-1.90	454.15	730424	1958	-55.13	-3.61	409.94
ESRO-4	730424	2202	47.83	-38.52	387.25	730424	2205	55.70	-39.42	429.43
ESRO-4	730425	706	-70.09	3.34	684.18	730425	707	-70.09	3.34	684.18
ESRO-4	730425	2014	-72.47	-7.61	430.52	730425	2017	-64.62	-9.27	388.14
ESRO-4	730425	2221	48.33	-44.15	409.50	730425	2224	56.15	-45.05	453.41
ESRO-4	730426	724	-66.64	-1.53	682.86	730426	726	-70.28	-2.30	658.10
ESRO-4	730426	1004	50.81	-37.73	917.82	730426	1006	47.41	-38.13	933.08
ESRO-4	730427	742	-63.19	-6.51	681.52	730427	745	-70.51	-7.95	631.80
ESRO-4	730427	1021	57.69	-42.45	901.84	730427	1025	47.50	-43.74	947.29
ESRO-4	730427	1915	-70.46	5.10	382.17	730427	1916	-70.46	5.10	382.17
ESRO-4	730428	801	-63.39	-12.14	655.42	730428	803	-67.06	-12.80	630.46
ESRO-4	730428	1934	-69.92	-0.60	361.86	730428	1936	-65.92	-1.40	343.73
ESRO-4	730428	2140	46.80	-36.35	462.92	730428	2142	50.66	-36.77	486.08
ESRO-4	730429	645	-72.02	4.86	574.13	730429	646	-72.02	4.86	574.13
ESRO-4	730429	1953	-69.35	-6.30	342.85	730429	1955	-65.33	-7.07	326.04
ESRO-4	730429	2159	47.20	-41.98	487.82	730429	2202	54.84	-42.85	535.61
ESRO-4	730430	703	-68.58	0.09	572.80	730430	705	-72.33	-0.81	547.96
ESRO-4	730430	943	50.30	-35.88	973.57	730430	945	46.96	-36.28	983.13
ESRO-4	730430	2011	-72.78	-11.03	341.97	730430	2014	-64.72	-12.75	309.86
ESRO-4	730501	721	-65.14	-4.84	571.46	730501	724	-72.68	-6.49	522.08
ESRO-4	730501	1000	57.14	-40.61	962.82	730501	1004	47.09	-41.88	991.19
ESRO-4	730502	740	-65.46	-10.48	545.31	730502	742	-69.25	-11.23	520.78
ESRO-4	730502	1019	57.26	-46.21	973.69	730502	1020	57.26	-46.21	973.69
ESRO-4	730502	1912	-70.54	1.63	305.58	730502	1913	-70.54	1.63	305.58
ESRO-4	730503	1931	-69.90	-4.09	291.47	730503	1933	-65.83	-4.90	279.62
ESRO-4	730503	2138	49.50	-40.20	596.40	730503	2141	56.90	-41.10	645.50
ESRO-4	730504	642	-71.03	1.57	465.93	730504	643	-71.03	1.57	465.93
ESRO-4	730504	923	46.65	-34.42	1006.55	730504	924	46.65	-34.42	1006.55
ESRO-4	730504	1950	-69.25	-9.80	279.07	730504	1952	-65.16	-10.58	268.92
ESRO-4	730504	2157	49.76	-45.82	622.75	730504	2159	53.44	-46.26	647.23

TABLE 3A. FLUX TUBE INTERSECTIONS (continued)

STATION - SANAE

SATELLITE	ENTRY DATE YYMMDD	ENTRY TIME HHMM	ENTRY LAT DEG	ENTRY LONG DEG	ENTRY ALT KM.	EXIT DATE YYMMDD	EXIT TIME HHMM	EXIT LAT DEG	EXIT LONG DEG	EXIT ALT KM.
ESRO-4	730505	659	-63.75	-2.57	488.12	730505	702	-71.48	-4.13	441.91
ESRO-4	730505	940	53.45	-39.21	1002.94	730505	943	46.81	-40.02	1007.99
ESRO-4	730506	718	-64.16	-8.22	463.45	730506	721	-71.95	-9.83	418.74
ESRO-4	730506	958	56.93	-44.36	1002.69	730506	1002	46.97	-45.62	1007.82
ESRO-4	730506	1850	-70.96	3.82	266.24	730506	1651	-70.96	3.82	266.24
ESRO-4	730507	737	-64.61	-13.88	439.51	730507	738	-64.61	-13.88	439.51
ESRO-4	730507	1909	-70.28	-1.90	257.94	730507	1911	-66.16	-2.73	251.79
ESRO-4	730507	2116	47.67	-38.00	681.47	730507	2119	54.89	-38.86	728.76
ESRO-4	730508	620	-70.03	3.86	391.43	730508	621	-70.03	3.86	391.43
ESRO-4	730508	1928	-69.58	-7.63	251.55	730508	1930	-65.46	-8.42	247.26
ESRO-4	730508	2135	47.82	-43.61	707.04	730508	2138	55.00	-44.47	753.34
ESRO-4	730509	638	-66.60	-1.01	390.34	730509	640	-70.56	-1.84	370.60
ESRO-4	730509	919	53.19	-37.35	1004.43	730509	922	46.53	-38.16	996.73
ESRO-4	730509	1948	-64.76	-14.11	244.72	730509	1949	-64.76	-14.11	244.72
ESRO-4	730510	656	-63.17	-6.00	389.24	730510	659	-71.12	-7.54	351.01
ESRO-4	730510	937	56.67	-42.50	1003.85	730510	941	46.67	-43.76	989.89
ESRO-4	730510	1828	-71.25	6.00	246.38	730510	1829	-71.25	6.00	246.38
ESRO-4	730511	715	-63.70	-11.66	368.54	730511	718	-71.70	-13.26	332.78
ESRO-4	730511	1847	-70.55	0.27	244.41	730511	1849	-66.42	-0.58	244.38
ESRO-4	730511	2055	49.08	-36.19	784.73	730511	2056	49.08	-36.19	784.73
ESRO-4	730512	1906	-69.85	-5.46	244.45	730512	1908	-65.72	-6.27	246.32
ESRO-4	730512	2113	45.61	-41.40	786.37	730512	2117	56.11	-42.67	847.72
ESRO-4	730513	617	-69.91	0.40	312.26	730513	618	-69.91	0.40	312.26
ESRO-4	730513	859	49.52	-35.91	968.70	730513	901	46.15	-36.30	958.07
ESRO-4	730513	1925	-69.14	-11.18	246.50	730513	1927	-65.02	-11.96	250.26
ESRO-4	730514	635	-66.49	-4.48	311.46	730514	637	-70.54	-5.32	297.44
ESRO-4	730514	916	56.35	-40.65	977.11	730514	920	46.26	-41.91	944.97
ESRO-4	730515	654	-67.11	-10.17	296.72	730515	656	-71.18	-11.04	284.29
ESRO-4	730515	935	56.47	-46.25	966.71	730515	936	56.47	-46.25	966.71
ESRO-4	730515	1825	-70.81	2.44	251.79	730515	1826	-70.81	2.44	251.79
ESRO-4	730516	537	-72.89	7.31	270.98	730516	538	-72.89	7.31	270.98
ESRO-4	730516	1844	-70.12	-3.29	258.26	730516	1846	-66.02	-4.11	266.15
ESRO-4	730516	2052	46.59	-39.57	875.54	730516	2056	56.86	-40.84	923.88
ESRO-4	730517	555	-69.47	2.59	270.46	730517	556	-69.47	2.59	270.46
ESRO-4	730517	839	45.57	-34.45	894.33	730517	840	45.57	-34.45	894.33
ESRO-4	730517	1903	-69.44	-9.01	266.64	730517	1905	-65.35	-9.80	276.30
ESRO-4	730517	2111	46.56	-45.17	894.12	730517	2115	56.77	-46.44	938.84
ESRO-4	730518	613	-66.04	-2.31	269.93	730518	615	-70.14	-3.13	261.33
ESRO-4	730518	856	52.46	-39.25	909.07	730518	859	45.61	-40.06	875.76
ESRO-4	730519	632	-66.72	-8.00	260.90	730519	634	-70.83	-8.86	254.11
ESRO-4	730519	914	55.94	-44.41	907.79	730519	917	49.08	-45.27	874.32
ESRO-4	730519	1803	-71.15	4.62	279.59	730519	1804	-71.15	4.62	279.59
ESRO-4	730520	1822	-70.50	-1.11	292.05	730520	1824	-66.44	-1.94	305.46
ESRO-4	730520	2031	47.25	-37.72	944.78	730520	2034	53.98	-38.55	967.53
ESRO-4	730521	1841	-69.86	-6.82	306.22	730521	1843	-65.82	-7.62	321.17
ESRO-4	730521	2050	47.14	-43.33	957.88	730521	2054	57.20	-44.60	985.85
ESRO-4	730522	552	-69.86	-0.96	245.02	730522	553	-69.86	-0.96	245.02
ESRO-4	730522	835	51.64	-37.42	828.31	730522	837	48.14	-37.83	807.84
ESRO-4	730522	1900	-69.25	-12.53	322.02	730522	1902	-65.23	-13.30	338.41
ESRO-4	730523	610	-66.44	-5.84	244.91	730523	612	-70.57	-6.69	244.19
ESRO-4	730523	853	55.11	-42.59	826.79	730523	856	48.09	-43.44	784.95
ESRO-4	730523	1741	-71.64	6.84	325.99	730523	1742	-71.64	6.84	325.99
ESRO-4	730524	629	-67.14	-11.54	244.18	730524	631	-71.27	-12.42	245.37
ESRO-4	730524	1800	-71.05	1.12	343.66	730524	1802	-67.06	0.26	361.72
ESRO-4	730524	2010	47.66	-35.87	989.72	730524	2012	51.00	-36.27	995.79
ESRO-4	730525	1819	-70.49	-4.59	362.73	730525	1821	-66.52	-5.42	382.01
ESRO-4	730525	2029	47.52	-41.47	996.56	730525	2033	57.50	-42.75	1006.03

TABLE 3A. FLUX TUBE INTERSECTIONS (continued)

STATION - SANAE

SATELLITE	ENTRY DATE YYMMDD	ENTRY TIME HHMM	ENTRY LAT DEG	ENTRY LONG DEG	ENTRY ALT KM.	EXIT DATE YYMMDD	EXIT TIME HHMM	EXIT LAT DEG	EXIT LONG DEG	EXIT ALT KM.
ESRO-4	730526	530	-69.60	1.21	249.57	730526	531	-69.60	1.21	249.57
ESRO-4	730526	815	46.84	-36.01	707.28	730526	816	46.84	-36.01	707.28
ESRO-4	730526	1838	-69.95	-10.29	383.08	730526	1840	-66.00	-11.09	403.48
ESRO-4	730527	548	-66.18	-3.69	249.77	730527	550	-70.30	-4.52	255.19
ESRO-4	730527	832	53.90	-40.79	728.98	730527	835	46.68	-41.63	681.71
ESRO-4	730528	607	-66.87	-9.38	255.49	730528	609	-70.98	-10.24	262.75
ESRO-4	730528	850	57.37	-45.94	727.31	730528	852	53.77	-46.40	703.82
ESRO-4	730528	1738	-71.85	3.39	409.87	730528	1739	-71.85	3.39	409.87
ESRO-4	730529	450	-72.70	8.11	274.17	730529	451	-72.70	8.11	274.17
ESRO-4	730529	625	-63.45	-14.36	255.79	730529	626	-63.45	-14.36	255.79
ESRO-4	730529	1757	-71.37	-2.31	432.67	730529	1800	-63.61	-3.86	478.32
ESRO-4	730529	2008	47.80	-39.61	1007.85	730529	2012	57.77	-40.89	998.18
ESRO-4	730530	508	-69.28	3.38	274.68	730530	509	-69.28	3.38	274.68
ESRO-4	730530	1816	-70.91	-8.00	456.37	730530	1819	-63.21	-9.50	503.37
ESRO-4	730530	2027	47.64	-45.21	1006.42	730530	2031	57.62	-46.49	992.20
ESRO-4	730531	526	-65.86	-1.52	275.19	730531	528	-69.94	-2.33	286.38
ESRO-4	730531	811	52.23	-39.00	621.21	730531	813	48.52	-39.43	596.64
ESRO-4	730531	1837	-62.85	-15.15	528.94	730531	1838	-62.85	-15.15	528.94

ORIGINAL PAGE IS OF POOR QUALITY

TABLE 3B. FLUX TUBE INTERSECTIONS

STATION - SANAE

SATELLITE	ENTRY DATE YYMMDD	ENTRY TIME HHMM	ENTRY LAT DEG	ENTRY LONG DEG	ENTRY ALT KM.	EXIT DATE YYMMDD	EXIT TIME HHMM	EXIT LAT DEG	EXIT LONG DEG	EXIT ALT KM.
ISIS-2	730415	1006	-72.78	5.52	1432.94	730415	1007	-72.78	5.52	1432.94
ISIS-2	730415	2139	-72.79	-0.05	1433.79	730415	2141	-69.67	0.67	1433.18
ISIS-2	730416	1040	-60.88	-6.76	1430.32	730416	1044	-70.26	-5.70	1432.91
ISIS-2	730416	2217	-72.19	-10.51	1433.21	730416	2222	-59.69	-8.95	1429.72
ISIS-2	730417	48	45.67	-40.84	1362.55	730417	52	55.24	-40.83	1357.67
ISIS-2	730417	1234	57.67	-42.64	1357.76	730417	1239	44.91	-42.59	1364.52
ISIS-2	730417	2101	-72.59	7.26	1432.81	730417	2102	-72.59	7.26	1432.81
ISIS-2	730418	1004	-67.33	1.07	1433.26	730418	1006	-70.45	1.59	1433.86
ISIS-2	730418	2139	-71.99	-3.20	1432.07	730418	2142	-65.74	-2.14	1430.22
ISIS-2	730419	1040	-61.68	-10.08	1432.51	730419	1044	-71.05	-8.90	1434.32
ISIS-2	730419	1159	47.83	-35.29	1365.01	730419	1201	44.64	-35.33	1366.97
ISIS-2	730419	2218	-68.27	-13.09	1430.26	730419	2221	-62.01	-12.45	1428.02
ISIS-2	730420	48	46.60	-44.21	1359.22	730420	52	56.18	-44.17	1355.06
ISIS-2	730420	1234	56.74	-45.98	1361.06	730420	1238	47.18	-45.92	1366.61
ISIS-2	730420	2101	-71.79	4.10	1430.67	730420	2102	-71.79	4.10	1430.67
ISIS-2	730421	1003	-65.01	-2.56	1434.06	730421	1006	-71.25	-1.60	1434.82
ISIS-2	730421	2139	-71.19	-6.38	1429.68	730421	2143	-61.81	-5.18	1426.04
ISIS-2	730422	10	46.88	-36.95	1357.51	730422	12	50.07	-36.97	1356.16
ISIS-2	730422	1039	-59.35	-13.57	1433.46	730422	1044	-71.85	-12.08	1435.00
ISIS-2	730422	1157	53.28	-38.65	1365.21	730422	1201	43.73	-38.70	1371.36
ISIS-2	730422	2220	-61.20	-15.76	1424.70	730422	2221	-61.20	-15.76	1424.70
ISIS-2	730423	927	-71.44	5.70	1435.05	730423	928	-71.44	5.70	1435.05
ISIS-2	730423	2101	-70.99	0.93	1427.89	730423	2103	-67.86	1.49	1426.63
ISIS-2	730424	1001	-59.55	-6.30	1434.20	730424	1006	-72.04	-4.78	1435.05
ISIS-2	730424	2139	-70.38	-9.57	1426.67	730424	2143	-60.99	-8.49	1422.39
ISIS-2	730425	9	44.63	-40.28	1356.41	730425	13	54.21	-40.30	1353.17
ISIS-2	730425	1039	-60.15	-16.90	1434.53	730425	1040	-60.15	-16.90	1434.53
ISIS-2	730425	1156	55.55	-42.04	1367.48	730425	1200	46.00	-42.03	1373.85
ISIS-2	730426	926	-69.12	1.97	1434.96	730426	928	-72.23	2.53	1434.83
ISIS-2	730426	2101	-70.18	-2.27	1424.53	730426	2103	-67.05	-1.77	1423.06
ISIS-2	730427	1001	-60.34	-9.63	1434.82	730427	1006	-72.83	-7.93	1434.56
ISIS-2	730427	1121	45.75	-34.77	1376.81	730427	1122	45.75	-34.77	1376.81
ISIS-2	730427	2139	-69.57	-12.78	1423.09	730427	2143	-60.16	-11.82	1418.26
ISIS-2	730428	9	45.57	-43.65	1354.53	730428	13	55.16	-43.64	1352.12
ISIS-2	730428	1155	57.82	-45.46	1369.91	730428	1159	48.28	-45.36	1376.46
ISIS-2	730429	925	-66.79	-1.84	1434.59	730429	927	-69.91	-1.36	1434.29
ISIS-2	730429	2100	-72.49	-6.18	1422.22	730429	2104	-63.09	-4.74	1417.29
ISIS-2	730429	2331	45.86	-36.39	1353.76	730429	2333	49.05	-36.42	1353.00
ISIS-2	730430	1001	-61.14	-12.96	1434.72	730430	1005	-70.51	-11.87	1433.86
ISIS-2	730430	1118	54.38	-38.12	1374.96	730430	1122	44.86	-38.14	1381.88
ISIS-2	730430	2141	-62.47	-15.32	1415.57	730430	2143	-59.33	-15.14	1413.74
ISIS-2	730501	2022	-72.28	1.14	1419.70	730501	2024	-69.14	1.81	1418.03
ISIS-2	730502	923	-61.33	-5.69	1434.28	730502	927	-70.70	-4.57	1432.91
ISIS-2	730502	2100	-71.66	-9.33	1418.06	730502	2105	-59.11	-7.87	1410.80
ISIS-2	730502	2331	46.80	-39.76	1353.05	730502	2335	56.39	-39.71	1352.03
ISIS-2	730503	1117	56.66	-41.53	1377.69	730503	1122	43.97	-41.52	1387.08
ISIS-2	730504	848	-70.90	2.73	1431.70	730504	849	-70.90	2.73	1431.70
ISIS-2	730504	2022	-71.45	-2.02	1415.30	730504	2025	-65.17	-1.02	1411.63
ISIS-2	730505	922	-59.00	-9.17	1433.51	730505	927	-71.50	-7.75	1430.84
ISIS-2	730505	1042	46.90	-34.21	1387.83	730505	1044	43.73	-34.26	1390.23
ISIS-2	730505	2100	-70.83	-12.50	1413.52	730505	2104	-61.41	-11.35	1407.83
ISIS-2	730505	2330	44.55	-43.08	1353.38	730505	2335	57.34	-43.04	1352.93
ISIS-2	730506	1117	55.78	-44.87	1382.79	730505	1121	46.27	-44.85	1389.87
ISIS-2	730506	1944	-71.23	5.29	1412.41	730506	1945	-71.23	5.29	1412.41
ISIS-2	730507	846	-65.45	-1.47	1431.09	730507	849	-71.70	-0.45	1429.23
ISIS-2	730507	2022	-70.61	-5.20	1410.57	730507	2025	-64.32	-4.31	1406.71
ISIS-2	730507	2252	44.84	-35.82	1353.64	730507	2254	48.04	-35.86	1353.51

TABLE 3B. FLUX TUBE INTERSECTIONS (continued)

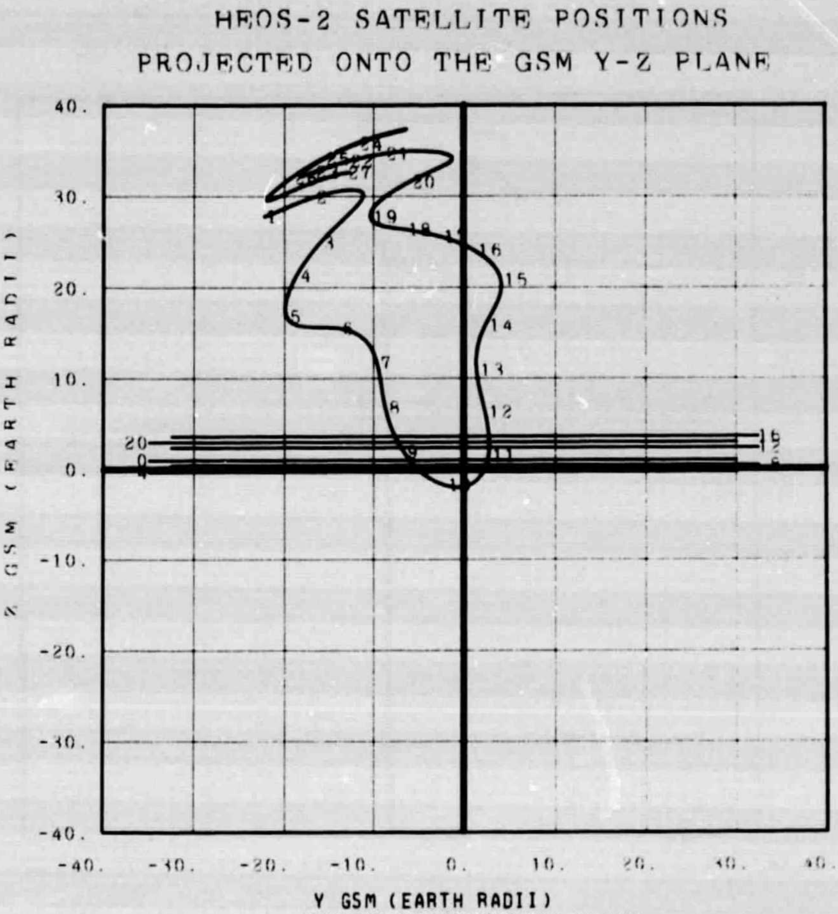
STATION - SANAE

SATELLITE	ENTRY DATE YYMMDD	ENTRY TIME HHMM	ENTRY LAT DEG	ENTRY LONG DEG	ENTRY ALT KM.	EXIT DATE YYMMDD	EXIT TIME HHMM	EXIT LAT DEG	EXIT LONG DEG	EXIT ALT KM.
ISIS-2	730508	922	-59.80	-12.50	1431.80	730508	927	-72.31	-10.92	1428.12
ISIS-2	730508	1040	52.37	-37.56	1388.30	730508	1043	46.03	-37.59	1393.03
ISIS-2	730508	2102	-63.70	-14.88	1404.78	730508	2104	-60.55	-14.67	1402.79
ISIS-2	730508	2331	48.70	-46.49	1353.85	730508	2334	55.09	-46.45	1354.19
ISIS-2	730509	810	-71.90	6.86	1427.39	730509	811	-71.90	6.86	1427.39
ISIS-2	730509	1944	-70.38	2.11	1407.53	730509	1945	-70.38	2.11	1407.53
ISIS-2	730510	845	-63.13	-5.05	1429.48	730510	849	-72.51	-3.61	1426.14
ISIS-2	730510	2021	-72.90	-9.13	1407.55	730510	2026	-60.31	-7.40	1399.64
ISIS-2	730510	2252	45.79	-39.19	1354.58	730510	2256	55.37	-39.18	1355.40
ISIS-2	730511	922	-60.61	-15.83	1429.43	730511	923	-60.61	-15.83	1429.43
ISIS-2	730511	1038	57.83	-41.02	1388.84	730511	1043	45.18	-40.96	1398.12
ISIS-2	730512	809	-69.59	3.00	1425.29	730512	811	-72.71	3.71	1423.95
ISIS-2	730512	1943	-72.67	-1.80	1404.46	730512	1946	-66.38	-0.62	1400.50
ISIS-2	730513	844	-60.81	-8.56	1427.64	730513	848	-70.20	-7.51	1423.91
ISIS-2	730513	1004	44.95	-33.71	1401.13	730513	1005	44.95	-33.71	1401.13
ISIS-2	730513	2021	-72.04	-12.26	1402.51	730513	2026	-59.44	-10.72	1394.55
ISIS-2	730513	2252	46.73	-42.56	1356.23	730513	2256	56.31	-42.52	1357.84
ISIS-2	730514	1038	56.97	-44.36	1393.98	730514	1043	44.33	-44.34	1403.01
ISIS-2	730514	1905	-72.43	5.53	1401.32	730514	1906	-72.43	5.53	1401.32
ISIS-2	730515	808	-67.28	-0.73	1422.98	730515	810	-70.41	-0.21	1421.53
ISIS-2	730515	1943	-71.81	-4.94	1399.37	730515	1947	-62.35	-3.62	1393.42
ISIS-2	730515	2213	43.82	-35.26	1357.18	730515	2215	47.01	-35.30	1357.64
ISIS-2	730516	844	-61.62	-11.88	1424.29	730516	848	-71.02	-10.71	1419.98
ISIS-2	730516	1002	50.42	-37.02	1401.49	730516	1005	44.11	-37.09	1405.84
ISIS-2	730516	2024	-61.71	-14.20	1391.50	730516	2025	-61.71	-14.20	1391.50
ISIS-2	730516	2252	47.67	-45.93	1358.57	730516	2256	57.24	-45.85	1360.91
ISIS-2	730517	1905	-71.56	2.39	1396.22	730517	1906	-71.56	2.39	1396.22
ISIS-2	730518	806	-61.83	-4.61	1421.95	730518	810	-71.23	-3.40	1417.33
ISIS-2	730518	1943	-70.93	-8.09	1394.28	730518	1947	-61.46	-6.92	1388.47
ISIS-2	730518	2213	44.76	-38.63	1359.66	730518	2217	54.33	-38.65	1362.09
ISIS-2	730519	843	-59.30	-15.37	1421.89	730519	845	-62.44	-15.20	1420.43
ISIS-2	730519	1000	55.89	-40.44	1401.89	730519	1004	46.43	-40.42	1408.16
ISIS-2	730520	731	-71.45	3.91	1414.53	730520	732	-71.45	3.91	1414.53
ISIS-2	730520	1905	-70.69	-0.78	1391.20	730520	1907	-67.53	-0.23	1389.29
ISIS-2	730521	805	-59.52	-8.10	1419.37	730521	810	-72.07	-6.56	1412.75
ISIS-2	730521	1943	-70.05	-11.27	1389.32	730521	1947	-60.56	-10.23	1383.76
ISIS-2	730521	2213	45.69	-42.00	1362.75	730521	2217	55.25	-41.99	1365.81
ISIS-2	730522	1000	55.06	-43.79	1406.42	730522	1004	45.61	-43.79	1412.23
ISIS-2	730523	729	-66.01	-0.36	1413.35	730523	732	-72.29	0.76	1409.78
ISIS-2	730523	1904	-72.95	-4.70	1388.21	730523	1908	-63.47	-3.16	1382.76
ISIS-2	730523	2135	45.96	-34.74	1364.98	730523	2136	45.96	-34.74	1364.98
ISIS-2	730524	805	-60.35	-11.43	1414.99	730524	810	-72.91	-9.70	1407.91
ISIS-2	730524	923	51.69	-36.49	1410.85	730524	926	45.40	-36.54	1414.45
ISIS-2	730524	1945	-62.83	-13.73	1381.07	730524	1947	-59.66	-13.55	1379.38
ISIS-2	730524	2213	46.61	-45.37	1366.38	730524	2217	56.16	-45.33	1369.98
ISIS-2	730525	653	-72.52	8.08	1406.73	730525	654	-72.52	8.08	1406.73
ISIS-2	730525	1826	-72.69	2.63	1385.29	730525	1828	-69.54	3.35	1383.51
ISIS-2	730526	728	-63.71	-3.94	1410.35	730526	731	-70.00	-3.13	1406.69
ISIS-2	730526	1904	-72.05	-7.82	1383.53	730526	1909	-59.39	-6.27	1376.89
ISIS-2	730526	2135	46.88	-38.11	1368.90	730526	2138	53.24	-38.12	1371.41
ISIS-2	730527	805	-61.19	-14.74	1410.29	730527	807	-64.33	-14.52	1408.49
ISIS-2	730527	922	54.02	-39.88	1412.80	730527	926	44.59	-39.92	1417.67
ISIS-2	730528	652	-70.23	4.18	1403.59	730528	653	-70.23	4.18	1403.59
ISIS-2	730528	1826	-71.79	-0.49	1380.81	730528	1828	-68.63	0.15	1379.17
ISIS-2	730529	727	-61.42	-7.47	1407.26	730529	731	-70.86	-6.31	1401.66
ISIS-2	730529	1904	-71.15	-10.96	1379.20	730529	1908	-61.64	-9.75	1374.64
ISIS-2	730529	2134	44.61	-41.44	1371.95	730529	2139	57.32	-41.40	1377.48

TABLE 3B. FLUX TUBE INTERSECTIONS (continued)

STATION - SANAE

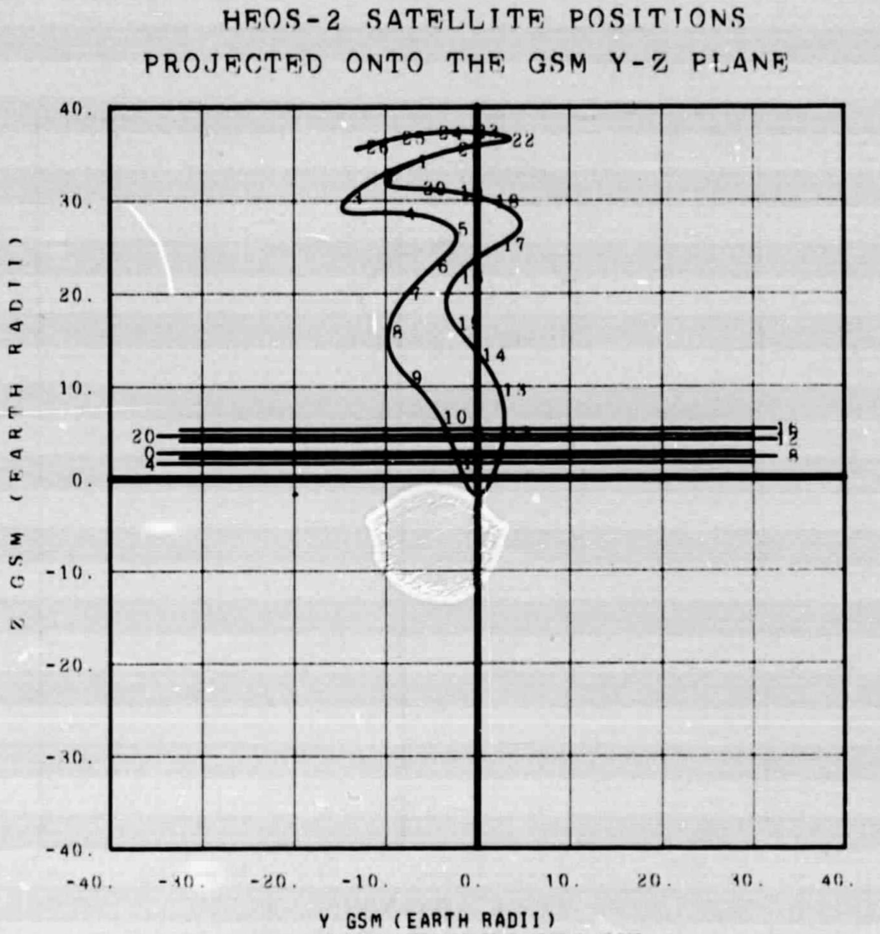
SATELLITE	ENTRY					EXIT				
	DATE YYMMDD	TIME HHMM	LAT DEG	LONG DEG	ALT KM.	DATE YYMMDD	TIME HHMM	LAT DEG	LONG DEG	ALT KM.
ISIS-2	730530	921	56.35	-43.29	1414.55	730530	926	43.78	-43.30	1420.28
ISIS-2	730530	1748	-71.53	6.84	1378.25	730530	1749	-71.53	6.84	1378.25
ISIS-2	730531	651	-67.95	0.43	1400.41	730531	653	-71.10	1.00	1398.51
ISIS-2	730531	1826	-70.88	-3.64	1376.74	730531	1829	-64.54	-2.71	1373.87
ISIS-2	730531	2056	44.87	-34.18	1374.76	730531	2057	44.87	-34.18	1374.76



INTERPRETATION OF TIME CODE-NUMBERS

1 -	1973/105	HOUR	0.00	R_E	35.7
2 -	1973/105	HOUR	4.78	R_E	34.4
3 -	1973/105	HOUR	16.13	R_E	29.8
4 -	1973/105	HOUR	18.43	R_E	28.6
5 -	1973/105	HOUR	22.38	R_E	26.2
6 -	1973/106	HOUR	5.13	R_E	21.2
7 -	1973/106	HOUR	10.87	R_E	15.6
8 -	1973/106	HOUR	14.18	R_E	11.4
9 -	1973/106	HOUR	16.80	R_E	7.2
10 -	1973/106	HOUR	18.97	R_E	2.9
11 -	1973/106	HOUR	20.75	R_E	3.7
12 -	1973/106	HOUR	22.63	R_E	7.2
13 -	1973/107	HOUR	1.35	R_E	11.4
14 -	1973/107	HOUR	5.45	R_E	16.4
15 -	1973/107	HOUR	10.82	R_E	21.5
16 -	1973/107	HOUR	14.45	R_E	24.3
17 -	1973/107	HOUR	16.77	R_E	25.9
18 -	1973/107	HOUR	19.05	R_E	27.3
19 -	1973/107	HOUR	23.42	R_E	29.8
20 -	1973/108	HOUR	4.85	R_E	32.2
21 -	1973/108	HOUR	16.28	R_E	35.4
22 -	1973/108	HOUR	18.13	R_E	36.3
23 -	1973/108	HOUR	20.57	R_E	36.7
24 -	1973/109	HOUR	5.03	R_E	37.8
25 -	1973/109	HOUR	17.12	R_E	37.6
26 -	1973/109	HOUR	19.08	R_E	37.4
27 -	1973/110	HOUR	6.40	R_E	35.3

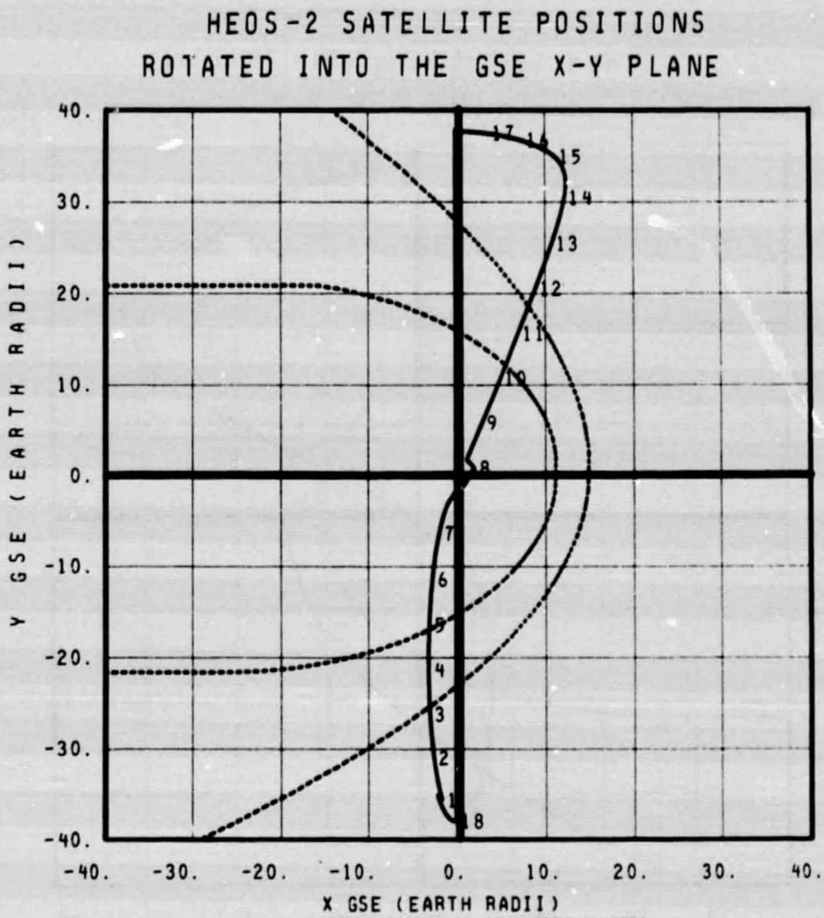
Figure 1. HEOS 2 position coordinates projected onto the GSM Y-Z plane at X_{GSM} = -20 R_E. The numbers along the trajectory refer to the table of times printed under the graph. The horizontal lines labeled at 4-hr intervals are the intersection of the geomagnetic equatorial plane with the X_{GSM} = -20 R_E plane representing an idealized position of the neutral sheet.



INTERPRETATION OF TIME CODE-NUMBERS

1 -	1973/146	HOUR 16.00	R_E 35.2	16 -	1973/149	HOUR 2.47	R_E 23.0
2 -	1973/146	HOUR 17.85	R_E 34.6	17 -	1973/149	HOUR 6.97	R_E 26.1
3 -	1973/146	HOUR 20.38	R_E 33.8	18 -	1973/149	HOUR 14.67	R_E 30.5
4 -	1973/147	HOUR 4.45	R_E 30.5	19 -	1973/149	HOUR 16.73	R_E 31.4
5 -	1973/147	HOUR 9.37	R_E 28.0	20 -	1973/149	HOUR 18.78	R_E 32.3
6 -	1973/147	HOUR 14.52	R_E 24.6	21 -	1973/150	HOUR 5.22	R_E 35.6
7 -	1973/147	HOUR 17.07	R_E 22.7	22 -	1973/150	HOUR 9.82	R_E 36.6
8 -	1973/147	HOUR 20.12	R_E 20.2	23 -	1973/150	HOUR 14.73	R_E 37.4
9 -	1973/148	HOUR 0.93	R_E 15.2	24 -	1973/150	HOUR 16.50	R_E 37.6
10 -	1973/148	HOUR 4.92	R_E 10.0	25 -	1973/150	HOUR 18.23	R_E 37.7
11 -	1973/148	HOUR 7.77	R_E 3.8	26 -	1973/150	HOUR 20.78	R_E 37.9
12 -	1973/148	HOUR 12.85	R_E 8.2				
13 -	1973/148	HOUR 15.50	R_E 11.9				
14 -	1973/148	HOUR 18.15	R_E 15.2				
15 -	1973/148	HOUR 21.25	R_E 18.5				

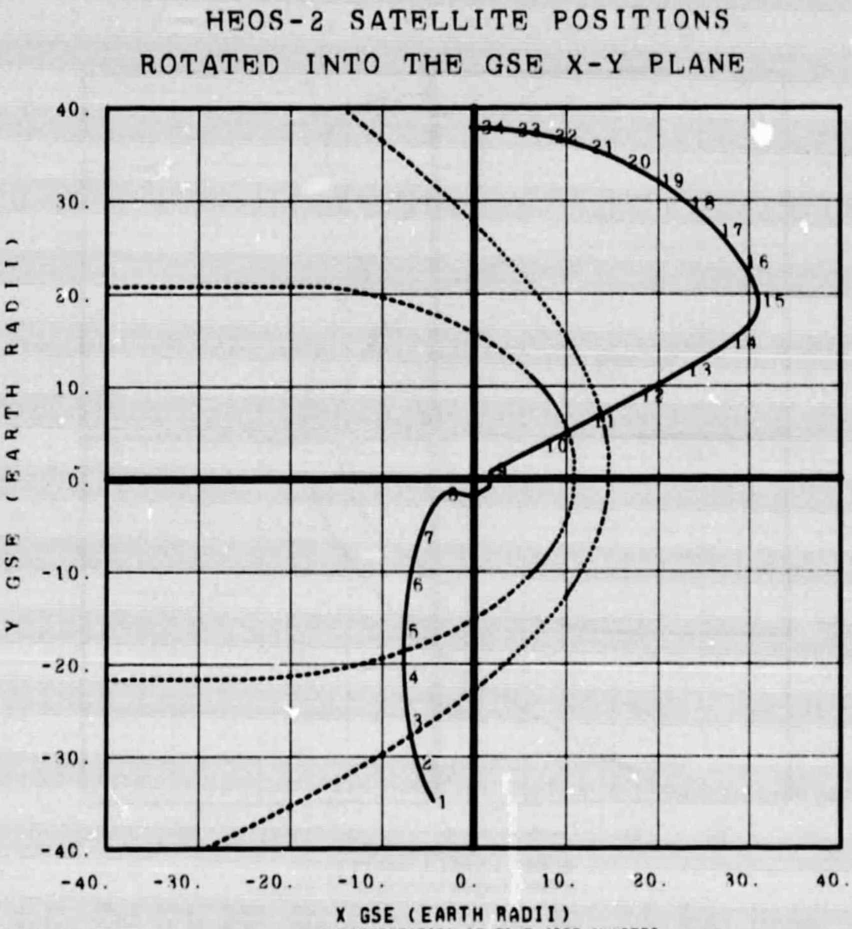
Figure 2. HEOS 2 position coordinates projected onto the GSM Y-Z plane at $X_{GSM} = -20\ R_E$. The numbers along the trajectory refer to the table of times printed under the graph. The horizontal lines labeled at 4-hr intervals are the intersection of the geomagnetic equatorial plane with the $X_{GSM} = -20\ R_E$ plane representing an idealized position of the neutral sheet.



INTERPRETATION OF TIME CODE-NUMBERS

1 -	1973/105	HOUR	0.00	LAT	82.76
2 -	1973/105	HOUR	13.25	LAT	77.18
3 -	1973/105	HOUR	21.98	LAT	72.18
4 -	1973/106	HOUR	4.58	LAT	66.75
5 -	1973/106	HOUR	9.77	LAT	60.04
6 -	1973/106	HOUR	13.88	LAT	50.37
7 -	1973/106	HOUR	17.08	LAT	32.22
8 -	1973/106	HOUR	19.80	LAT	89.07
9 -	1973/106	HOUR	22.20	LAT	30.31
10 -	1973/107	HOUR	1.52	LAT	51.26
11 -	1973/107	HOUR	5.93	LAT	61.79
12 -	1973/107	HOUR	11.68	LAT	68.99
13 -	1973/107	HOUR	19.27	LAT	74.85
14 -	1973/108	HOUR	5.87	LAT	80.41
15 -	1973/108	HOUR	19.63	LAT	85.80
16 -	1973/109	HOUR	0.90	LAT	87.60
17 -	1973/109	HOUR	3.03	LAT	88.29
18 -	1973/109	HOUR	8.72	LAT	89.32

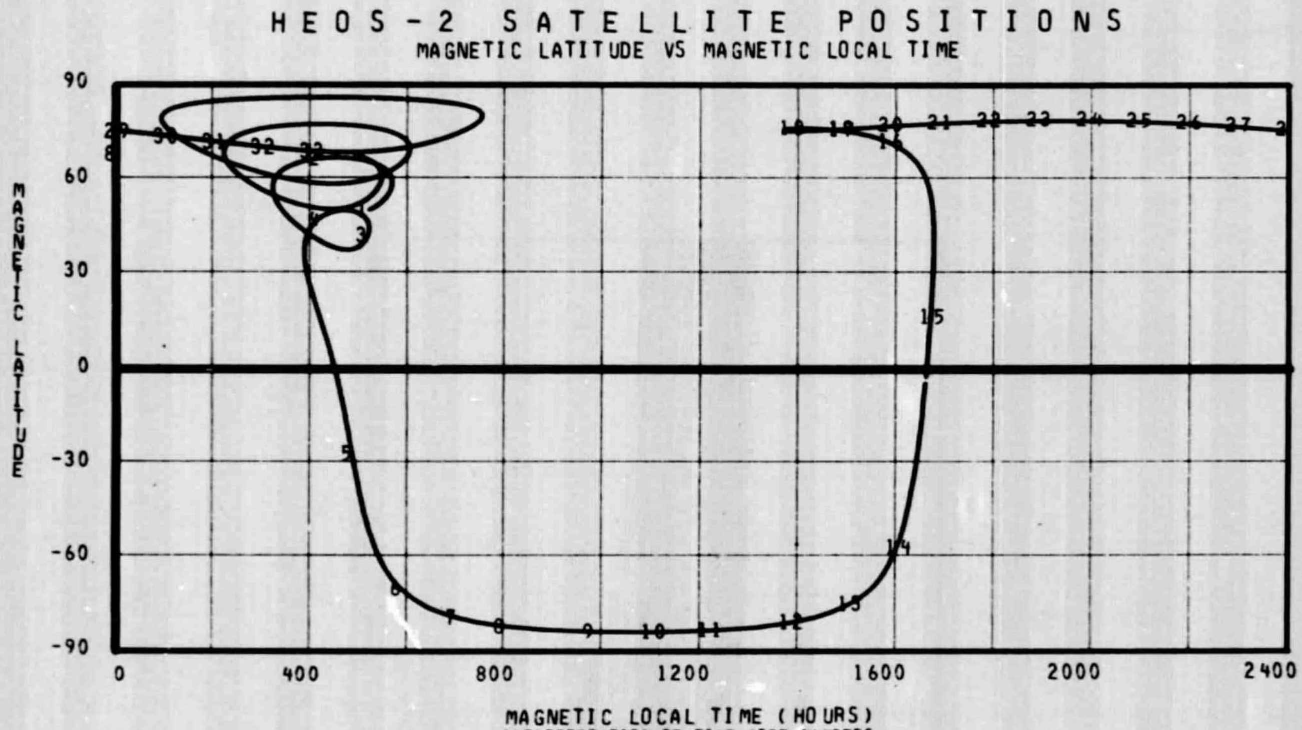
Figure 3. HEOS 2 position coordinates rotated into the ecliptic plane. The numbers along the trajectory refer to the table of times printed under the graph. The two dashed lines represent average positions of the bow shock and the magnetopause.



INTERPRETATION OF TIME CODE-NUMBERS

1 -	1973/145	HOUR	16.00	LAT	82.12
2 -	1973/147	HOUR	2.78	LAT	77.49
3 -	1973/147	HOUR	10.82	LAT	73.01
4 -	1973/147	HOUR	17.17	LAT	68.11
5 -	1973/147	HOUR	22.32	LAT	62.16
6 -	1973/148	HOUR	2.48	LAT	54.08
7 -	1973/148	HOUR	5.80	LAT	40.85
8 -	1973/148	HOUR	8.45	LAT	3.45
9 -	1973/148	HOUR	9.97	LAT	40.79
10 -	1973/148	HOUR	12.97	LAT	39.32
11 -	1973/148	HOUR	17.08	LAT	56.30
12 -	1973/148	HOUR	22.67	LAT	65.78
13 -	1973/149	HOUR	6.18	LAT	72.72
14 -	1973/149	HOUR	16.85	LAT	78.92
15 -	1973/150	HOUR	8.88	LAT	85.42
16 -	1973/150	HOUR	15.22	LAT	87.59
17 -	1973/150	HOUR	17.50	LAT	88.32
18 -	1973/150	HOUR	18.70	LAT	88.69
19 -	1973/150	HOUR	19.47	LAT	88.91
20 -	1973/150	HOUR	20.02	LAT	89.05
21 -	1973/150	HOUR	20.45	LAT	89.16
22 -	1973/150	HOUR	20.80	LAT	89.23
23 -	1973/150	HOUR	21.08	LAT	89.29
24 -	1973/150	HOUR	21.33	LAT	89.32

Figure 4. HEOS 2 position coordinates rotated into the ecliptic plane. The numbers along the trajectory refer to the table of times printed under the graph. The two dashed lines represent average positions of the bow shock and the magnetopause.



INTERPRETATION OF TIME CODE-NUMBERS

1	1973/105	HOUR 0.00	R_E 35.7	12	1973/106	HOUR 19.60	R_E 1.9	23	1973/107	HOUR 10.90	R_E 21.6
2	1973/105	HOUR 9.35	R_E 32.8	13	1973/106	HOUR 19.65	R_E 1.9	24	1973/107	HOUR 11.72	R_E 22.2
3	1973/106	HOUR 2.40	R_E 23.4	14	1973/106	HOUR 19.78	R_E 1.8	25	1973/107	HOUR 12.52	R_E 22.9
4	1973/106	HOUR 9.87	R_E 16.7	15	1973/106	HOUR 20.45	R_E 2.7	26	1973/107	HOUR 13.35	R_E 23.5
5	1973/106	HOUR 18.60	R_E 3.9	16	1973/106	HOUR 23.08	R_E 7.9	27	1973/107	HOUR 14.23	R_E 24.2
6	1973/106	HOUR 19.37	R_E 2.3	17	1973/107	HOUR 0.22	R_E 9.7	28	1973/107	HOUR 15.22	R_E 24.9
7	1973/106	HOUR 19.47	R_E 2.1	18	1973/107	HOUR 1.83	R_E 12.0	29	1973/107	HOUR 15.25	R_E 24.9
8	1973/106	HOUR 19.50	R_E 2.0	19	1973/107	HOUR 6.45	R_E 17.5	30	1973/107	HOUR 16.35	R_E 25.6
9	1973/106	HOUR 19.53	R_E 2.0	20	1973/107	HOUR 7.92	R_E 18.9	31	1973/107	HOUR 17.58	R_E 26.4
10	1973/106	HOUR 19.55	R_E 2.0	21	1973/107	HOUR 9.07	R_E 20.0	32	1973/107	HOUR 19.00	R_E 27.3
11	1973/106	HOUR 19.57	R_E 2.0	22	1973/107	HOUR 10.03	R_E 20.8	33	1973/107	HOUR 20.63	R_E 28.3

Figure 5. HEOS 2 magnetic latitude versus magnetic local time. The numbers along the trajectory refer to the table of times printed under the graph.

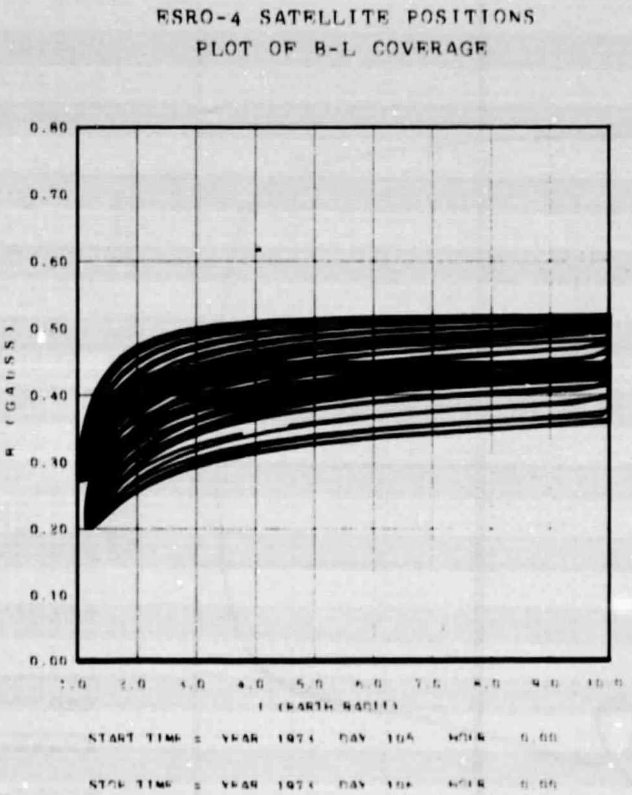


Figure 6. ESRO 4 positions plot of B-L (magnetic field-McIlwain parameter) coverage.

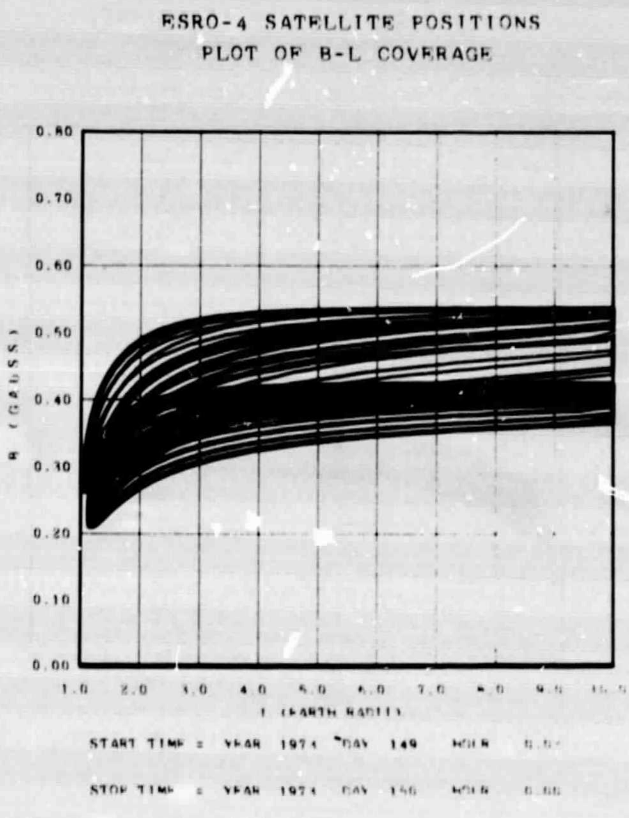


Figure 7. ESRO 4 positions plot of B-L (magnetic field-McIlwain parameter) coverage.

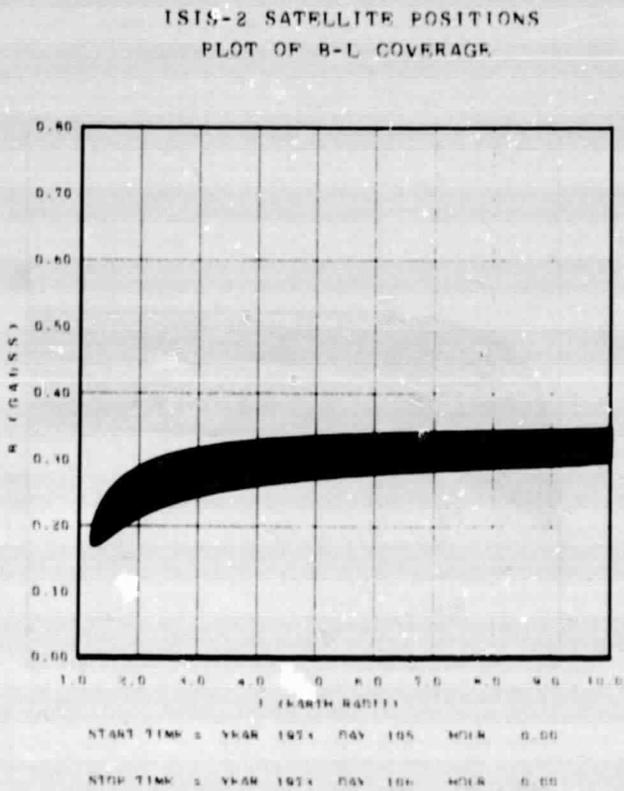


Figure 8. ISIS 2 positions plot of B-L (magnetic field-McIlwain parameter) coverage.

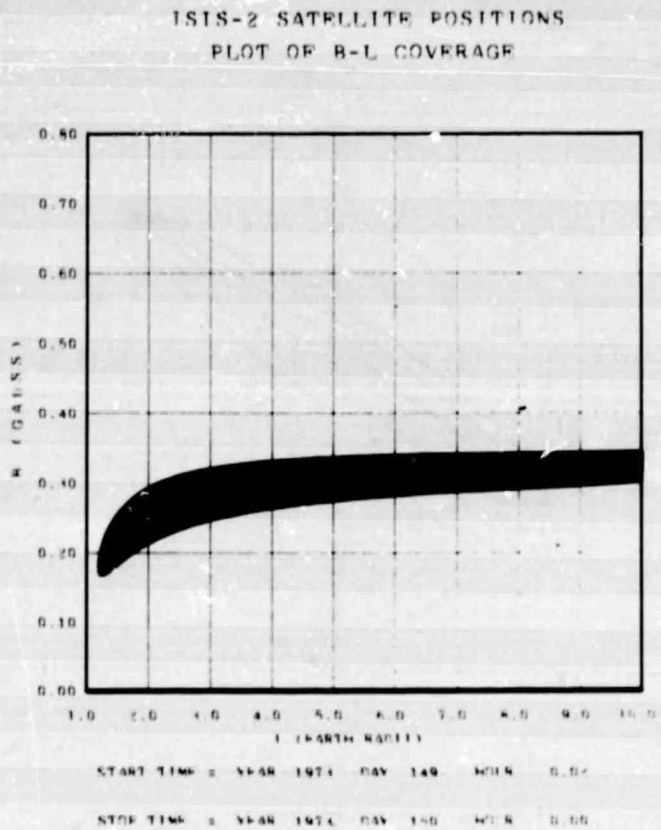


Figure 9. ISIS 2 positions plot of B-L (magnetic field-McIlwain parameter) coverage.

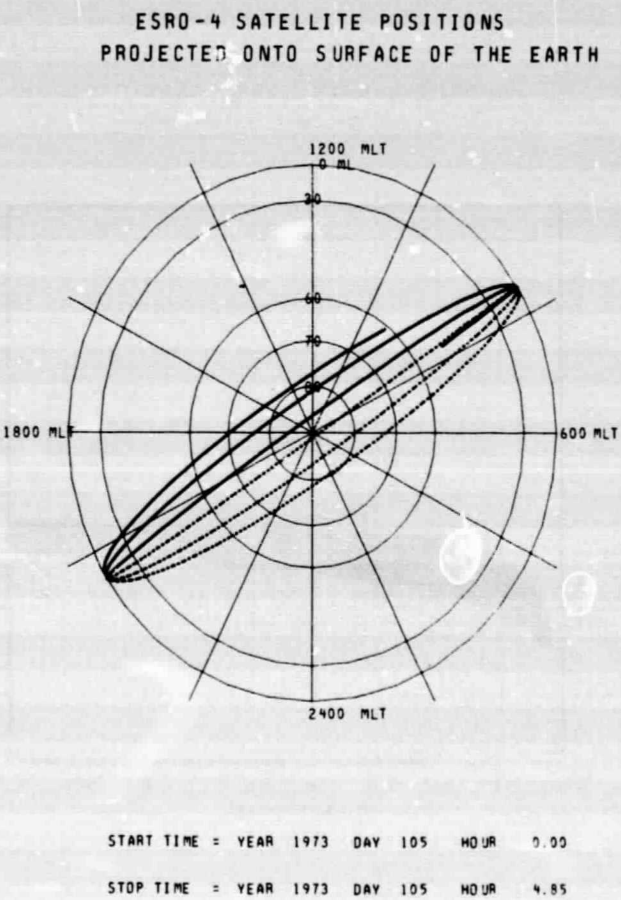


Figure 10. ESRO 4 positions projected onto the earth's surface using magnetic latitude and magnetic local time as polar coordinates. The solid lines correspond to Northern Hemisphere portions, and the dashed lines correspond to Southern Hemisphere portions.

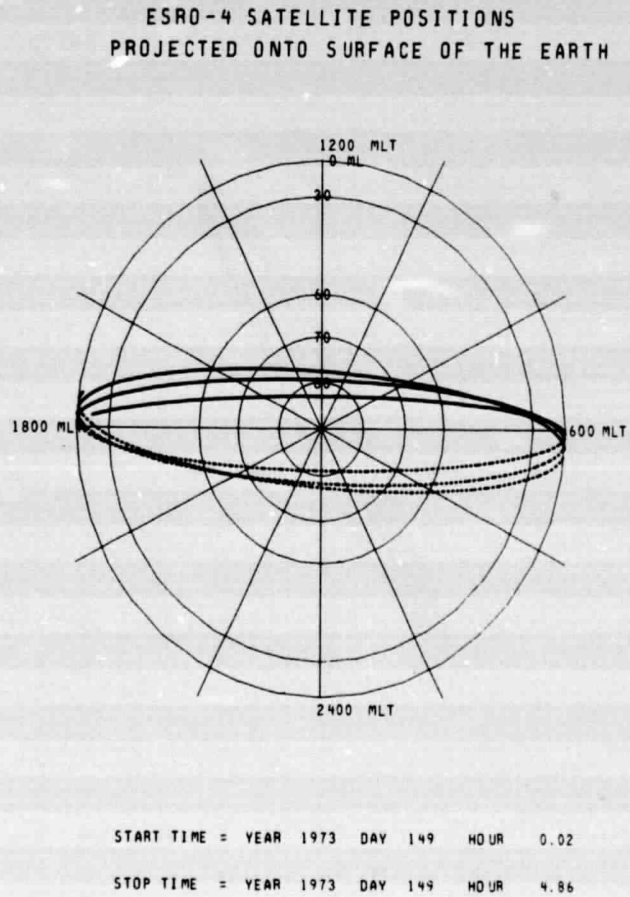


Figure 11. ESRO 4 positions projected onto the earth's surface using magnetic latitude and magnetic local time as polar coordinates. The solid lines correspond to Northern Hemisphere portions, and the dashed lines correspond to Southern Hemisphere portions.

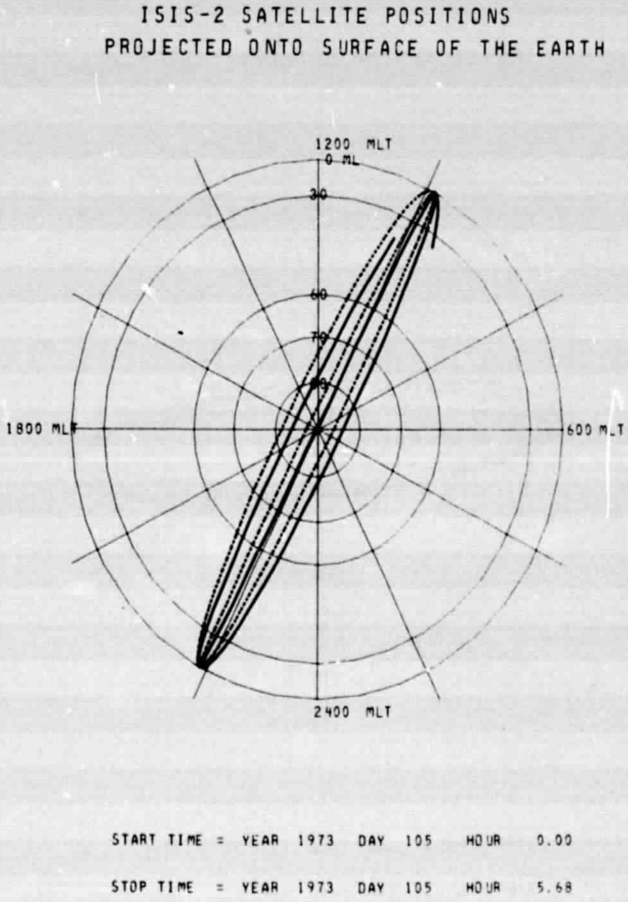


Figure 12. ISIS 2 positions projected onto the earth's surface using magnetic latitude and magnetic local time as polar coordinates. The solid lines correspond to Northern Hemisphere portions, and the dashed lines correspond to Southern Hemisphere portions.

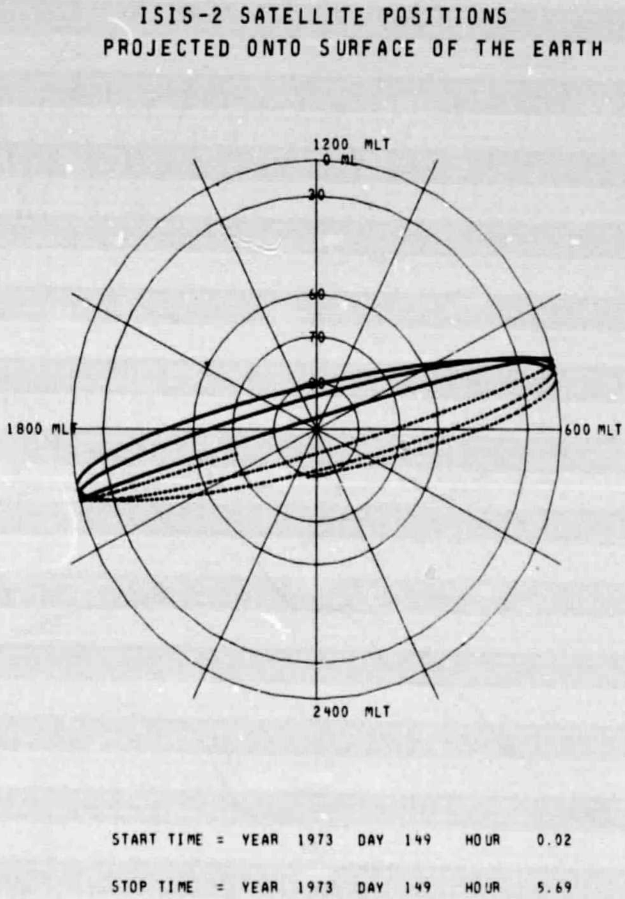


Figure 13. ISIS 2 positions projected onto the earth's surface using magnetic latitude and magnetic local time as polar coordinates. The solid lines correspond to Northern Hemisphere portions, and the dashed lines correspond to Southern Hemisphere portions.

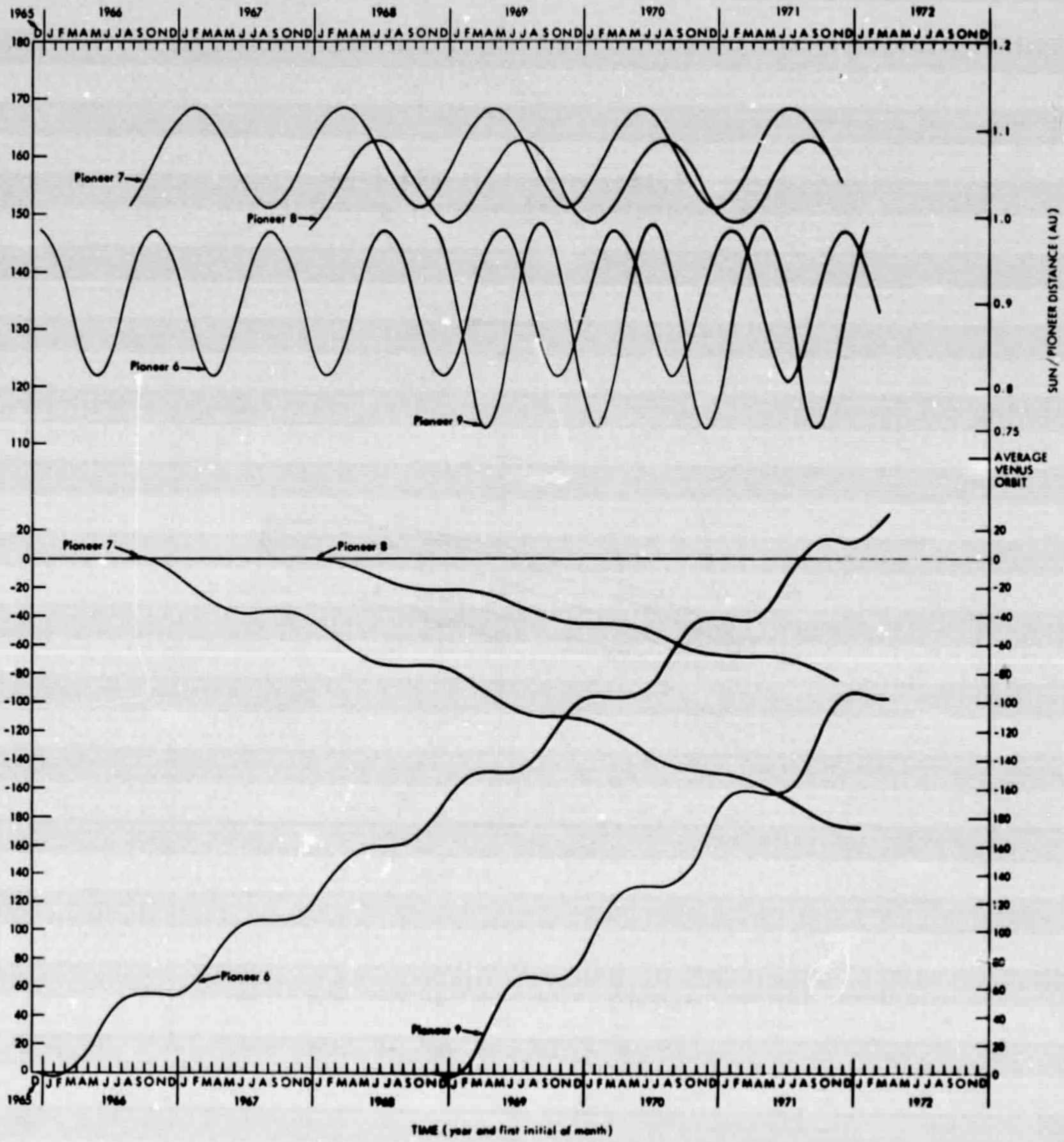


Figure 14. Radial distance from the sun and earth-sun-satellite angle as a function of time for the Pioneer 6, 7, 8, and 9 spacecraft from 1966 through 1972. Positive angles are measured counterclockwise from the earth-sun line as viewed from the north ecliptic pole.

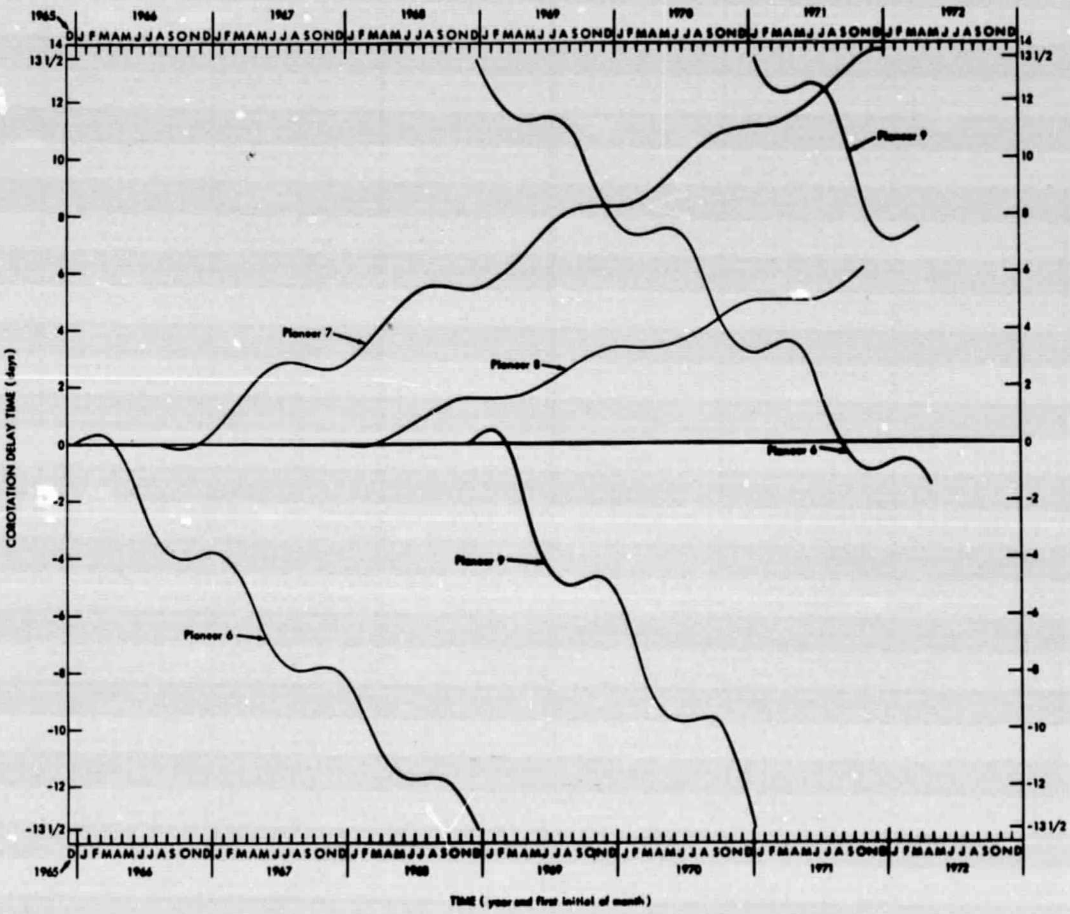


Figure 15. Corotation delay time in days as a function of time for the Pioneer 6, 7, 8, and 9 spacecraft from 1966 through 1972. Values represent the number of days between observations at the spacecraft and at earth of the corotating interplanetary magnetic flux tube, assuming a solar wind speed of 400 km/sec.

APPENDIX 1

IMS SATELLITE SITUATION CENTER
STATUS REPORT FOR ACTIVE AND PLANNED IMS SPACECRAFT
(DATED 05/21/73)

SPACECRAFT COMMON NAME- ISIS 2 NSSDC ID 71-024A
ALTERNATE NAMES- ISIS-B, PL-701F

LAUNCH DATE- 04/01/71 SPACECRAFT WEIGHT IN ORBIT- 248.6 KG

LAUNCH SITE- VANDENBERG AFB, UNITED STATES LAUNCH VEHICLE- DELTA

FUNDING AGENCY

CANADA	CRC
UNITED STATES	NASA-OSS

INITIAL ORBIT PARAMETERS
EPOCH DATE- 04/01/71 ORBIT TYPE- GEOCENTRIC ORBIT PERIOD- 113.61 MIN
APOAPSIS- 1429. KM ALT PERIAPSIS- 1367. KM ALT INCLINATION- 88.1564 DEG

PRESENT ORBIT PARAMETERS
EPOCH DATE- 01/22/72 ORBIT TYPE- GEOCENTRIC ORBIT PERIOD- 113.61 MIN
APOAPSIS- 1429. KM ALT PERIAPSIS- 1373. KM ALT INCLINATION- 88.1577 DEG

SPACECRAFT PERSONNEL (PM=PROJECT MANAGER, PS=PROJECT SCIENTIST)

PM - J.E.	JACKSON	NASA-GSFC	GREENBELT, MD.
PM - J.H.	WHITTEKER	COMM RESEARCH CENTRE	OTTAWA, ONTARIO, CANADA
PS - E.S.	WARREN	COMM RESEARCH CENTRE	OTTAWA, ONTARIO, CANADA
PS - J.E.	JACKSON	NASA-GSFC	GREENBELT, MD.

SPACECRAFT BRIEF DESCRIPTION

ISIS 2 WAS AN IONOSPHERIC OBSERVATORY INSTRUMENTED WITH A SWEEP FREQUENCY AND A FIXED FREQUENCY IONOSONDE, A VLF RECEIVER, ENERGETIC AND SOFT PARTICLE DETECTORS, AN ION MASS SPECTROMETER, AN ELECTROSTATIC PROBE, A RETARDING POTENTIAL ANALYZER, A BEACON TRANSMITTER, A COSMIC NOISE EXPERIMENT, AND TWO PHOTOMETERS. THE SOUNDER USED TWO LONG CROSSED-DIPOLE ANTENNAS (78.9 M AND 20.2 M LONG, RESPECTIVELY) FOR THE SOUNDING, VLF, AND COSMIC NOISE EXPERIMENTS. THE SPACECRAFT WAS SPIN STABILIZED TO ABOUT 2 RPM AFTER ANTENNA DEPLOYMENT. ATTITUDE AND SPIN INFORMATION WAS OBTAINED FROM A THREE-AXIS MAGNETOMETER AND A SUN SENSOR. SOME CONTROL OF ATTITUDE AND SPIN WERE POSSIBLE BY MEANS OF MAGNETIC TORQUING. THE EXPERIMENT PACKAGE ALSO INCLUDED A PROGRAMMABLE TAPE RECORDER WITH A 1-HR CAPACITY. FOR NON-RECORDED OBSERVATIONS, DATA FROM SATELLITE AND SUBSATELLITE LOCATIONS WERE TELEMETERED WHEN THE SPACECRAFT WAS IN SIGHT OF A TELEMETRY STATION. TELEMETRY STATIONS ARE LOCATED SO THAT PRIMARY DATA COVERAGE IS NEAR THE 80 DEG W MERIDIAN AND NEAR HAWAII, SINGAPORE, AUSTRALIA, ENGLAND, INDIA, JAPAN, ANTARCTICA, NEW ZEALAND, AND CENTRAL AFRICA.

AS OF 05/16/73 THE SPACECRAFT STATUS WAS NORMAL
AND THE DATA ACQUISITION RATE WAS STANDARD.

EXPERIMENT NAME- SWEEP FREQUENCY SOUNDER NSSDC ID 71-024A-01

EXPERIMENT PERSONNEL (PI=PRINCIPAL INVESTIGATOR, OI=OTHER INVESTIGATOR)

OI - G.E.K.	LOCKWOOD	COMM RESEARCH CENTRE	OTTAWA, ONTARIO, CANADA
OI - G.L.	NELMS	COMM RESEARCH CENTRE	OTTAWA, ONTARIO, CANADA
OI - J.	TURNER	DEPARTMENT OF INTERIOR	SYDNEY, AUSTRALIA

OI - C.	TAIEB	CNET	ISSY-LESS MOULTNEAUX, SEINE, FRANCE
OI - O.	HOLT	THE AURORAL OBS.	TRCMSO, NORWAY
OI - Y.	OGATA	RRL	TOKYO, JAPAN
OI - R.	RAGHAVARAO	PHYSICAL RESEARCH LAB	AHMEDABAD 9, INDIA

EXPERIMENT BRIEF DESCRIPTION

THE ISIS 2 IONOSONDE WAS A RADIO TRANSMITTER THAT RECORDED THE TIME DELAY BETWEEN A TRANSMITTED AND RETURNED RADIO FREQUENCY PULSE. A CONTINUUM OF FREQUENCIES BETWEEN .1 AND 20 MHZ WERE SAMPLED EVERY 14 OR 21 SEC, AND ONE OF SIX SELECTED FREQUENCIES WAS ALSO USED FOR SOUNDING FOR A FEW SECONDS DURING THE 14- OR 21-SEC PERIOD. IN ADDITION TO THE SWEEP- AND FIXED-FREQUENCY MODES OF OPERATION, A MIXED MODE, IN WHICH THE TRANSMITTER FREQUENCY WAS FIXED AT ONE OF SIX POSSIBLE FREQUENCIES WHILE THE RECEIVER SWEPT WAS POSSIBLE. SEVERAL VIRTUAL RANGE (DELAY TIME) PROFILES RESULTING FROM GROUND REFLECTIONS, PLASMA RESONANCES, BIREFRINGENCE OF THE IONOSPHERE, NON-VERTICAL PROPAGATION, ETC., WERE NORMALLY OBSERVED. VIRTUAL RANGE AT A GIVEN FREQUENCY WAS PRIMARILY A FUNCTION OF DISTANCE TRAVERSED BY THE SIGNAL, ELECTRON DENSITY ALONG THE PROPAGATION PATH, AND MODE OF PROPAGATION. THE STANDARD DATA FORM WAS AN IONOGRAM (GRAPH) SHOWING VIRTUAL RANGE AS A FUNCTION OF RADIO FREQUENCY. TWO OTHER FORMS OF DATA ARE COMMONLY PREPARED FROM THE IONOGRAMS. THEY ARE DIGITAL FREQUENCY AND/OR VIRTUAL HEIGHT VALUES OF CHARACTERISTIC IONOSPHERIC FEATURES AND COMPUTATIONS OF ELECTRON DENSITY PROFILES.

AS OF 05/16/73 THE SPACECRAFT STATUS WAS NORMAL
AND THE DATA ACQUISITION RATE WAS STANDARD.

AS OF 05/16/73 THE EXPERIMENT STATUS WAS NORMAL
AND THE DATA ACQUISITION RATE WAS STANDARD.

EXPERIMENT NAME- FIXED FREQUENCY SOUNDER NSSDC ID 71-024A-02

EXPERIMENT PERSONNEL (PI=PRINCIPAL INVESTIGATOR, OI=OTHER INVESTIGATOR)

PI - W.	CALVERT	NOAA	BOULDER, COLO.
OI - T.E.	VAN ZANDT	NOAA	BOULDER, COLO.
OI - G.L.	NELMS	COMM RESEARCH CENTRE	OTTAWA, ONTARIO, CANADA
OI - C.E.	PETRIE	COMM RESEARCH CENTRE	OTTAWA, ONTARIO, CANADA
OI - G.E.K.	LOCKWOOD	COMM RESEARCH CENTRE	OTTAWA, ONTARIO, CANADA
OI - J.H.	WHITTEKER	COMM RESEARCH CENTRE	OTTAWA, ONTARIO, CANADA

EXPERIMENT BRIEF DESCRIPTION

THE FIXED FREQUENCY SOUNDER OPERATED FROM THE SAME ANTENNA, TRANSMITTER, AND RECIEVER USED FOR THE SWEEP FREQUENCY EXPERIMENT. IT NORMALLY OPERATED FOR 3 TO 5 SEC DURING THE FREQUENCY FLY-BACK PERIOD OF THE SWEEP FREQUENCY OPERATION WHICH WAS EVERY 14 OR 21 SEC. ONE OF SIX FREQUENCIES (0.12, 0.48, 1.00, 1.95, 4.00, OR 9.303 MHZ) WAS CHOSEN FOR USE BY THE EXPERIMENTER, AS DESIRED. OTHER MODES OF OPERATION WERE AVAILABLE INCLUDING CONTINUOUS OBSERVATION AT A SELECTED FREQUENCY AND A SPECIAL MIXED MODE WITH TRANSMISSION AT A SELECTED ONE OF THE SIX FIXED FREQUENCIES AND SWEEP RECEPTION. THIS EXPERIMENT WAS DESIGNED TO STUDY IONOSPHERIC FEATURES OF A SMALLER SCALE THAN COULD BE DETECTED BY THE SWEEP SOUNDER, AND TO STUDY PLASMA RESONANCES. PARAMETERS MEASURED WERE VIRTUAL RANGE (A FUNCTION OF PROPAGATION TIME OF THE REFLECTED PULSE) AND TIME (A FUNCTION OF GEOGRAPHICAL POSITION). THESE DATA WERE NORMALLY OBSERVED ONLY WHEN THE

SPACECRAFT WAS IN RANGE OF THE TELEMETRY STATION. A LIMITED AMOUNT OF DATA WAS TAPE RECORDED DURING THE FIRST YEAR AFTER LAUNCH. EXPERIMENT OPERATION HAS BEEN NOMINAL SINCE LAUNCH.

AS OF 05/16/73 THE SPACECRAFT STATUS WAS NORMAL AND THE DATA ACQUISITION RATE WAS STANDARD.

AS OF 05/16/73 THE EXPERIMENT STATUS WAS NORMAL AND THE DATA ACQUISITION RATE WAS STANDARD.

EXPERIMENT NAME- VLF RECEIVER NSSDC ID 71-024A-03

EXPERIMENT PERSONNEL (PI=PRINCIPAL INVESTIGATOR, OI=OTHER INVESTIGATOR)

PI - R.E.	BARRINGTON	COMM RESEARCH CENTRE	OTTAWA, ONTARIO, CANADA

EXPERIMENT BRIEF DESCRIPTION

THE VERY LOW FREQUENCY (VLF) EXPERIMENT WAS A LOW-FREQUENCY (LF) BROADBAND RECEIVER THAT OBSERVED SIGNALS FROM THE 79 M LONG DIPOLE (SPLIT MONOPOLE) ANTENNA BETWEEN .05 AND 30 KHZ. THIS SAME ANTENNA WAS USED FOR RECEIVING SIGNALS BELOW 5 MHZ ON THE IONOSONDE. THE VLF RECEIVER HAD A WIDE DYNAMIC RANGE ACHEIVED BY USE OF AN AUTOMATIC GAIN CONTROL (AGC) SYSTEM. THIS VLF EXPERIMENT INCLUDED AN ONBOARD EXCITER THAT SWEPT AT A NONLINEAR RATE FROM 50 TO ZERO HZ, THEN TO 9500 HZ, OVER A PERIOD OF 1.0 SEC. THIS PERMITTED THE CONTROLLED STUDY OF ION RESONANCES STIMULATED BY THE EXCITER, IN ADDITION TO STUDY OF NATURAL AND OTHER MAN MADE VLF RADIO NOISE. THE EXPERIMENT ALSO PERMITTED ANTENNA IMPEDANCE MEASUREMENTS, WITH OR WITHOUT A DC BIAS ON THE ANTENNA. THE REAL-TIME DATA WERE TRANSMITTED ON 136.08 MHZ TELEMENTRY. THE VLF DATA COULD BE RECORDED ON ONE OF THE FOUR TAPE RECORDER CHANNELS FOR THE FIRST YEAR WHEN THE SPACECRAFT TAPE RECORDER WAS OPERATING. TAPE RECORDED (AND BACKUP REAL-TIME CAPABILITY) DATA WAS TRANSMITTED ON 400-MHZ TELEMETRY. THIS EXPERIMENT HAS OPERATED NOMINALLY SINCE LAUNCH.

AS OF 05/16/73 THE SPACECRAFT STATUS WAS NORMAL AND THE DATA ACQUISITION RATE WAS STANDARD.

AS OF 05/15/73 THE EXPERIMENT STATUS WAS NORMAL AND THE DATA ACQUISITION RATE WAS STANDARD.

EXPERIMENT NAME- ENERGETIC PARTICLE DETECTORS NSSDC ID 71-024A-04

EXPERIMENT PERSONNEL (PI=PRINCIPAL INVESTIGATOR, OI=OTHER INVESTIGATOR)

PI - I.B.	MCDIARMID	NATIONAL RSCH COUNCIL	OTTAWA, ONTARIO, CANADA
OI - J.R.	BURROWS	NATIONAL RSCH COUNCIL	OTTAWA, ONTARIO, CANADA

EXPERIMENT BRIEF DESCRIPTION

THIS EXPERIMENT CONSISTS OF FOUR SETS OF DETECTORS. THE FIRST, MADE UP OF FOUR GEIGER COUNTERS, MEASURES ELECTRONS GREATER THAN 20 AND 40 KEV AND PROTONS GREATER THAN 300 AND 500 KEV PARALLEL TO AND PERPENDICULAR TO THE SATELLITE SPIN AXIS. ALL REMAINING DETECTORS MEASURE PARTICLES PERPENDICULAR TO THE SPIN AXIS. THE SECOND SET CONSISTS OF 2 SOLID-STATE SILICON JUNCTION DETECTORS. THESE HAVE THRESHOLDS OF 80, 100, 120, AND 200

KEV FOR ELECTRONS AND 200 AND 400 KEV FOR PROTONS. THE THIRD SET CONSISTS OF 4 SILICON JUNCTION DETECTORS WHICH MEASURE PROTONS IN THE ENERGY RANGE 0.15 TO 55 MEV. THE FOURTH SET IS COMPOSED OF 2 CESIUM IODIDE SCINTILLATION-PHOTOMULTIPLIER SYSTEMS. EACH WILL OPERATE IN TWO DIFFERENT MODES. THE SYSTEM WILL RESPOND TO ELECTRONS GREATER THAN 3, 40, AND 60 KEV AND PROTONS GREATER THAN 20 AND 50 KEV.

AS OF 05/16/73 THE SPACECRAFT STATUS WAS NORMAL
AND THE DATA ACQUISITION RATE WAS STANDARD.

AS OF 05/15/73 THE EXPERIMENT STATUS WAS NORMAL
AND THE DATA ACQUISITION RATE WAS STANDARD.

EXPERIMENT NAME- SOFT PARTICLE SPECTROMETER NSSDC ID 71-024A-05

EXPERIMENT PERSONNEL (PI=PRINCIPAL INVESTIGATOR, OI=OTHER INVESTIGATOR)
PI - W.J. HEIKKILA U OF TEXAS DALLAS, TEXAS

EXPERIMENT BRIEF DESCRIPTION

THE SOFT PARTICLE SPECTROMETER (WHICH IS BASICALLY AN ELECTROSTATIC ANALYZER) IS USED TO STUDY THE DIRECTIONAL INTENSITY AND DIFFERENTIAL ENERGY SPECTRA OF PROTONS AND ELECTRONS IN ORDER TO OBTAIN A GREATER UNDERSTANDING OF AURORAS, GEOMAGNETIC DISTURBANCES, AND VARIOUS IONOSPHERIC FEATURES. DIFFERENTIAL ENERGY SPECTRA ARE OBTAINED IN THE ENERGY RANGE 10 EV TO 10 KEV WITH A 20 PERCENT ENERGY RESOLUTION. THE VOLTAGE SWEEP PROGRAM OF THE ANALYZER IS FLEXIBLE.

AS OF 05/16/73 THE SPACECRAFT STATUS WAS NORMAL
AND THE DATA ACQUISITION RATE WAS STANDARD.

AS OF 05/15/73 THE EXPERIMENT STATUS WAS NORMAL
AND THE DATA ACQUISITION RATE WAS STANDARD.

EXPERIMENT NAME- ION MASS SPECTROMETER NSSDC ID 71-024A-06

EXPERIMENT PERSONNEL (PI=PRINCIPAL INVESTIGATOR, OI=OTHER INVESTIGATOR)
PI - J.H. HOFFMAN U OF TEXAS DALLAS, TEXAS

EXPERIMENT BRIEF DESCRIPTION

THIS MAGNETIC ION MASS SPECTROMETER EXPERIMENT WAS FLOWN TO MEASURE THE DISTRIBUTION OF THE CONCENTRATIONS OF THE ION SPECIES AS A FUNCTION OF TIME AND POSITION, WITH PARTICULAR INTEREST FOCUSED ON THE POLAR WIND PARTICLES. THE INSTRUMENT HAD TWO ION DETECTOR SYSTEMS, AND MASS SCANNING THROUGH THE RANGE FROM 1 TO 64 AMU WAS ACCOMPLISHED IN TWO SECTIONS -- 1 TO 8 AMU AND 8 TO 64 AMU. TWO ION BEAMS EMERGED FROM THE MAGNETIC SECTOR OF THE INSTRUMENT AND WERE SIMULTANEOUSLY DETECTED BY ELECTRON MULTIPLIERS AND LOG ELECTROMETER AMPLIFIERS. A CIRCUIT FOLLOWING EACH AMPLIFIER DETECTED THE PEAK AMPLITUDE OF THE ION CURRENT. THIS PEAK VALUE, RATHER THAN THE ENTIRE MASS SPECTRUM, WAS TRANSMITTED IN ORDER TO REDUCE THE REQUIRED TELEMETRY BANDWIDTH. IN THIS MODE OF OPERATION, THE COMPLETE MASS RANGE WAS SCANNED IN 1 SEC. A BACKUP MODE WAS PROVIDED WHICH PRODUCED AN ANALOG OUTPUT WITH A

SWEEP PERIOD OF 8 SEC. AS OF JANUARY 1972, 10 MONTHS AFTER LAUNCH, THE EXPERIMENT WAS OPERATING SUCCESSFULLY WITH MOST OF THE DATA OBTAINED IN THE PEAK MODE. FOR ABOUT 2 MIN PER PASS OVER OTTAWA, CANADA, THE EXPERIMENT OPERATED IN THE ANALOG MODE. INFLIGHT CALIBRATION WAS ACHIEVED BY COMPARING ION CONCENTRATION MEASUREMENTS AT APPROPRIATE ALTITUDES, I.E., WHERE A SINGLE ION SPECIES PREDOMINATED, WITH ELECTRON DATA FROM THE SOUNDER ON BOARD. OTHER COMPARISONS WERE MADE BETWEEN THE SPECTROMETER OUTPUT AND MEASUREMENTS OBTAINED FROM OTHER RELATED EXPERIMENTS ON BOARD.

AS OF 05/16/73 THE SPACECRAFT STATUS WAS NORMAL
AND THE DATA ACQUISITION RATE WAS STANDARD.

AS OF 04/11/73 THE EXPERIMENT STATUS WAS NORMAL
AND THE DATA ACQUISITION RATE WAS STANDARD.

EXPERIMENT NAME- CYLINDRICAL ELECTROSTATIC PROBE   NSSDC ID 71-024A-07

EXPERIMENT PERSONNEL (PI=PRINCIPAL INVESTIGATOR, OI=OTHER INVESTIGATOR)

PI - L.H.	BRACE	NASA-GSFC	GREENBELT, MD.
OI - J.A.	FINDLAY	NASA-GSFC	GREENBELT, MD.

EXPERIMENT BRIEF DESCRIPTION

THE PURPOSE OF THIS EXPERIMENT WAS TO STUDY THE GLOBAL VARIATIONS OF ELECTRON TEMPERATURE AND ELECTRON CONCENTRATION AT SPACECRAFT (SC) ALTITUDES DURING SOLAR MAXIMUM, AND TO STUDY CHARACTERISTICS OF THIS SC ION SHEATH. THIS CYLINDRICAL PROBE WAS A TYPE OF LANGMUIR PROBE THAT OBSERVED CURRENT FLOW TO THE PROBE FOR A GIVEN VOLTAGE PROFILE PLACED ON THE COLLECTOR. FROM THIS CURRENT-VOLTAGE PROFILE, ELECTRON DENSITY, AND ELECTRON TEMPERATURE COULD BE CALCULATED. THERE WAS A BOOM PROBE AND AN AXIAL PROBE EXTENDING FROM THE SC. THE AXIAL PROBE EXTENDED 48.3 CM FROM THE SC, ALONG THE SPIN AXIS, AND WAS VENTERED BETWEEN THE FOUR TELEMETRY ANTENNAS ON THE UNDERSIDE OF THE SC. THIS PROBE WAS CAPABLE OF MEASUREMENTS UNPERTURBED BY THE SATELLITE MOTION ONLY WHEN THE PROBE PRECEDED THE SC IN ITS MOTION THROUGH THE PLASMA. THE BOOM PROBE EXTENDED HORIZONTALLY AND OUTWARD (IN SC FRAME OF REFERENCE) FROM A BOOM 1 M LONG, WHICH IN TURN EXTENDED FROM AN UPPER SURFACE OF THE SATELLITE AT AN ANGLE OF ABOUT 45 DEG TO THE SPIN AXIS. THIS PROBE PROVIDED SOME OBSERVATIONS DURING EACH SC SPIN CYCLE, WHICH WERE FREE OF SC WAKE EFFECTS. THE PROBES CONSISTED OF THREE CONCENTRIC, ELECTRICALLY ISOLATED, STAINLESS STEEL TUBES. THE OUTER (0.24- CM DIA AND 23 CM LONG) TUBE FLOATED AT ITS OWN EQUILIBRIUM POTENTIAL AND SERVED TO PLACE THE COLLECTOR WELL AWAY FROM THE SC PLASMA SHEATH. THE CENTER TUBE (0.165- CM DIA) EXTENDING 2.3 CM OUTWARD FROM THE OUTER TUBE ACTED AS AN ELECTRICAL GUARD FOR THE COLLECTOR. ITS ELECTRICAL POTENTIAL WAS CONTROLLED. THE COLLECTOR (0.058- CM DIA) EXTENDED 23 CM OUTWARD FROM THE DRIVEN GUARD. DURING EACH 2-MIN SEQUENCE, 1- VOLT-AMPERE CURVE WAS OBTAINED THAT CAN BE INTERPRETED IN ELECTRON DENSITIES OVER A RANGE FROM 100 TO 400,000 ELECTRONS PER CM SQ. THIS EXPERIMENT HAS OPERATED NOMINALLY SINCE LAUNCH.

AS OF 05/16/73 THE SPACECRAFT STATUS WAS NORMAL
AND THE DATA ACQUISITION RATE WAS STANDARD.

AS OF 05/01/73 THE EXPERIMENT STATUS WAS NORMAL
AND THE DATA ACQUISITION RATE WAS STANDARD.

EXPERIMENT NAME- RETARDING POTENTIAL ANALYZER NSSDC ID 71-024A-08

EXPERIMENT PERSONNEL (PI=PRINCIPAL INVESTIGATOR, OI=OTHER INVESTIGATOR)

PI - E.J.R.	MAIER	NASA-GSFC	GREENBELT, MD.
OI - M.	SMIDDY	AFCRL	BEDFORD, MASS.
OI - B.E.	TROY, JR.	NASA-GSFC	GREENBELT, MD.
OI - J.L.	DONLEY	NASA-GSFC	GREENBELT, MD.

EXPERIMENT BRIEF DESCRIPTION

THIS EXPERIMENT MEASURED ION AND/OR ELECTRON CURRENT IN ORDER TO STUDY HEAT TRANSFER PROCESSES WHICH ARE IMPORTANT IN THE DYNAMICS OF THE IONOSPHERE. THIS RETARDING POTENTIAL ANALYZER CONSISTED OF THREE GRIDS (APERTURE GRID, RETARDING GRID AND A SUPPRESSOR GRID) WHICH PROVIDED A VOLT-AMPERE CURVE RELATING SWEEP VOLTAGE ON THE RETARDING GRID TO CURRENT FLOW TO THE COLLECTOR. ANALYSIS OF THE CURVES COULD PROVIDE ION/ELECTRON TEMPERATURES AND DENSITIES. THE EXPERIMENT OPERATED NOMINALLY FROM LAUNCH TO THE PRESENT (MAY 1973).

AS OF 05/16/73 THE SPACECRAFT STATUS WAS NORMAL AND THE DATA ACQUISITION RATE WAS STANDARD.

AS OF 05/01/73 THE EXPERIMENT STATUS WAS NORMAL AND THE DATA ACQUISITION RATE WAS STANDARD.

EXPERIMENT NAME- RADIO BEACON NSSDC ID 71-024A-09

EXPERIMENT PERSONNEL (PI=PRINCIPAL INVESTIGATOR, OI=OTHER INVESTIGATOR)

PI - P.A.	FORSYTH	WESTERN ONTARIO U	LONDON, ONTARIO, CANADA
OI - C.	LYON	WESTERN ONTARIO U	LONDON, ONTARIO, CANADA

EXPERIMENT BRIEF DESCRIPTION

A CW TRANSMITTER (137 TO 138 MHZ BAND) RADIATING ABOUT 100 MW AND OPERATING IN CONJUNCTION WITH TRACKING BEACON (136 TO 137 MHZ BAND) PROVIDED FACILITIES FOR OBSERVING SCINTILLATIONS FROM IRREGULARITIES, DETERMINING MAGNITUDES AND POSITIONS, AND EVALUATING ELECTRON CONTENT BETWEEN GROUND OBSERVER AND SATELLITE. INTERFERENCE DIFFICULTIES WITH OTHER SPACECRAFT OPERATIONS PREVENTED NOMINAL ELECTRON CONTENT DATA FROM BEING OBTAINED. HOWEVER SOME LIMITED AMOUNT OF USEFUL SCINTILLATION DATA WAS OBSERVED.

AS OF 05/16/73 THE SPACECRAFT STATUS WAS NORMAL AND THE DATA ACQUISITION RATE WAS STANDARD.

AS OF 05/01/73 THE EXPERIMENT STATUS WAS PARTIAL AND THE DATA ACQUISITION RATE WAS SUB-STANDARD.

EXPERIMENT NAME- COSMIC RADIO NOISE NSSDC ID 71-024A-10

EXPERIMENT PERSONNEL (PI=PRINCIPAL INVESTIGATOR, OI=OTHER INVESTIGATOR)
PI - T.R. HARTZ COMM RESEARCH CENTRE OTTAWA, ONTARIO, CANADA

EXPERIMENT BRIEF DESCRIPTION

THIS EXPERIMENT USES THE SWEEP FREQUENCY IONOSONDE RECEIVER AGC VOLTAGES AUTOMATIC GAIN CONTROL VOLTAGE TO MEASURE GALACTIC AND SOLAR RADIO NOISE LEVELS. THE RECEIVER SWEEPS FROM 0.1 TO 20 MHZ. THE DYNAMIC RANGE IS 50 DB, AND THE BANDWIDTH IS 55 KHZ. THE ANTENNAS USED ARE 2?.?M AND 78.9 M DIPOLES.

AS OF 05/16/73 THE SPACECRAFT STATUS WAS NORMAL AND THE DATA ACQUISITION RATE WAS STANDARD.

AS OF 05/16/73 THE EXPERIMENT STATUS WAS NORMAL AND THE DATA ACQUISITION RATE WAS STANDARD.

EXPERIMENT NAME- 3914-5577 A PHOTOMETER NSSDC ID 71-024A-11

EXPERIMENT PERSONNEL (PI=PRINCIPAL INVESTIGATOR, OI=OTHER INVESTIGATOR)
PI - C.D. ANGER U OF CALGARY EDMONTON, ALBERTA, CANADA

EXPERIMENT BRIEF DESCRIPTION

THIS DUAL WAVELENGTH SCANNING AURORAL PHOTOMETER WAS DESIGNED TO MAP THE DISTRIBUTION OF AURORAL EMISSIONS AT 5577 AND 3914 A OVER THE PORTION OF THE DARK EARTH VISIBLE TO THE SPACECRAFT. A COMBINATION OF INTERNAL ELECTRONIC SCANNING PERFORMED BY AN IMAGE DISSECTOR AND OF THE NATURAL ORBITAL AND ROTATIONAL MOTIONS OF THE SPACECRAFT PERMITTED THE SENSOR TO SYSTEMATICALLY SCAN ACROSS THE EARTH. THE DETECTOR SYSTEM WAS CONSTRUCTED TO ALLOW INCIDENT RADIATION TO BE ACCEPTED FROM TWO DIRECTIONS 180 DEG APART AND THEN TO FOCUS THIS LIGHT AT A COMMON POINT ON THE SINGLE IMAGE DISSECTOR PHOTOMETER TUBE. FOR EACH DIRECTION, THE LIGHT PASSED THROUGH ITS OWN LENS, INTERFERENCE FILTER, AND MIRROR. ONE FILTER OPERATED IN THE RANGE 5581 PLUS OR MINUS 9 A (AT THE HALF-MAXIMUM POINTS), AND THE OTHER FILTER OPERATED AT 3915 PLUS OR MINUS 13 A. ONLY ONE OF THE TWO OPTICAL SYSTEMS POINTED AT THE EARTH AT ANY ONE TIME, WHILE THE OTHER FACED INTO SPACE. WHEN THE SPACECRAFT SPIN AXIS WAS ORIENTED TO LIE IN THE ORBITAL PLANE, EACH ROTATION OF THE SPACECRAFT RESULTED IN AN EARTH SCAN 5 DEG WIDE. THIS WIDTH SIZE WAS CHOSEN TO INSURE OVERLAP WITH THE PREVIOUS SCAN. THE IMAGE DISSECTOR REPETITIVELY SCANNED AT A HIGH SPEED ACROSS THE NARROW DIMENSION OF EACH 5-DEG BAND AND DIVIDED IT INTO SEPARATELY RESOLVED REGIONS 0.4 DEG BY 0.4 DEG. SIMILAR STRIPS WERE SCANNED AT EACH OF THE TWO WAVELENGTHS, BUT AT TIMES THAT DIFFERED BY HALF THE ROTATION PERIOD OF ABOUT 10 SEC. A CALIBRATION LIGHT SOURCE FOR EACH WAVELENGTH WAS BUILT INTO THE OPTICAL ASSEMBLY, AND A CALIBRATE CYCLE WAS INITIATED AUTOMATICALLY WHENEVER A POWER ON COMMAND WAS GIVEN. TO MINIMIZE THE PROBLEMS ARISING FROM SOLAR ILLUMINATION OF THE OPTICS AND THE DIRECT VIEWING OF THE SUNLIT EARTH, A SUNLIGHT PROTECTION SYSTEM WAS INCLUDED. THE ELECTRONIC PORTION OF THE INSTRUMENT CONSISTED OF MODULES THAT AMPLIFIED AND COUNTED OUTPUT PULSES FROM THE IMAGE DISSECTOR TUBE AND CONVERTED THESE INTO A HIGH-RATE PULSE CODE MODULATED OUTPUT AND A LOW-RATE ANALOG OUTPUT. THE DATA WILL BE REPRODUCED DIRECTLY IN THE FORM OF SEPARATE PICTURES REPRESENTING EMISSIONS AT EACH WAVELENGTH, WHICH WILL BE USED TO STUDY THE LARGE-SCALE DISTRIBUTION AND MORPHOLOGY OF AURORAS AND TO COMPARE WITH OTHER MEASUREMENTS FROM THIS AND OTHER SPACECRAFT AND FROM

GROUND-BASED INSTRUMENTS. AS OF OCTOBER 12, 1971, THE EXPERIMENT WAS OPERATING SATISFACTORILY. COMPLETE DETAILS ABOUT THE EXPERIMENT CAN BE FOUND IN THE UNPUBLISHED REPORT 'THE ISIS-2 SCANNING AURCRAL PHOTOMETER,' C. D. ANGER, T. FANCOTT, J. MCNALLY, AND H. S. KERR.

AS OF 05/16/73 THE SPACECRAFT STATUS WAS NCRMAL AND THE DATA ACQUISITION RATE WAS STANDARD.

AS OF 04/11/73 THE EXPERIMENT STATUS WAS NORMAL AND THE DATA ACQUISITION RATE WAS STANDARD.

EXPERIMENT NAME- 6300 A PHOTOMETER NSSDC ID 71-024A-12

EXPERIMENT PERSONNEL (PI=PRINCIPAL INVESTIGATOR, OI=OTHER INVESTIGATOR)
PI - G.G. SHEPHERD YORK U SASKATOON, SASKATCHEWAN, CANADA

EXPERIMENT BRIEF DESCRIPTION

A TWO-CHANNEL PHOTOMETER WAS USED TO DIRECTLY MEASURE AND MAP THE INTENSITY OF THE ATOMIC OXYGEN RED LINE AT 6300 A IN CAY, TWILIGHT, AND NIGHT AIRGLOW AND IN THE AURORA. EACH CHANNEL HAD A SEPARATE OPTICAL INPUT. THE TWO INPUTS WERE LOCATED AT THE SAME END OF THE SPACECRAFT BUT WERE POINTED IN OPPOSITE DIRECTIONS. ONE CHANNEL WAS FOR RED LIGHT AND HAD A BANDWIDTH OF 10 A CENTERED AT 6300 A. THE OTHER WAS FOR WHITE LIGHT AND HAD A 100-A BANDWIDTH. IN THE CARTWHEEL MODE, THE SPIN AXIS OF THE SATELLITE WAS PERPENDICULAR TO THE ORBIT PLANE. THE TWO OPTICAL INPUT AXES WERE PERPENDICULAR TO THE SPIN AXIS. THEREFORE, THESE TWO OPENINGS COULD SCAN THE AREA BELOW AS THE SATELLITE SPUN. ONE CHANNEL VIEWED THE EARTH WHILE THE OTHER POINTED AT THE DARK SKY. THE FIELD OF VIEW WAS 2.5 DEG IN ANGULAR DIAMETER, GIVING A RESOLUTION OF ABOUT 140 KM ON THE GROUND. SINCE THIS WAS THE DISTANCE COVERED BY THE SPACECRAFT IN ONE 20-SEC SPIN PERIOD, A RASTER TYPE SCAN OF THE EARTH RESULTED. BAFFLING OF THE OPTICAL INPUTS ALLOWED OPERATION OF THE EXPERIMENT WHILE THE SPACECRAFT WAS IN SUNLIGHT, PROVIDED THAT THE SUN WAS MORE THAN 50 DEG OFF THE OPTICAL AXIS. THE EXPERIMENT IS OPERATING NORMALLY AS OF APRIL 1973.

AS OF 05/16/73 THE SPACECRAFT STATUS WAS NORMAL AND THE DATA ACQUISITION RATE WAS STANDARD.

AS OF 04/11/73 THE EXPERIMENT STATUS WAS NORMAL AND THE DATA ACQUISITION RATE WAS STANDARD.